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Model geographic Information System Infrastructure for Local Health Departments in Connecticut.

Lemuel Skidmore

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**MODEL GEOGRAPHIC INFORMATION SYSTEM
INFRASTRUCTURE FOR LOCAL HEALTH DEPARTMENTS IN
CONNECTICUT**

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B.A., Hawthorne College, 1972

M.S., Indiana State University, 1975

A Thesis

Submitted in Partial Fulfillment of the

Requirements for the Degree of

Master of Public Health

at the

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APPROVAL PAGE

Master of Public Health Thesis

Model Geographic Information System Infrastructure for Local Health Departments
in Connecticut

Presented by

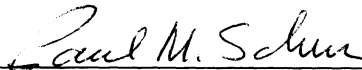
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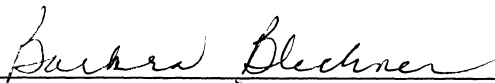
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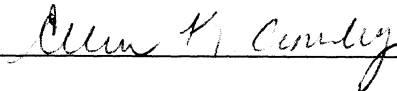
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2005

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Lastly, the legalities: the following trademarks may be included in the text:

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ABSTRACT

One inhibiting characteristic of information systems in the business world is that they evolved from specific needs for specific business areas, rather than as components of an integrated whole. The result is expensive retooling, as well as unnecessary labor cost to enter, analyze, and reconcile redundant data.

As local health departments (LHDs) attempt to implement Geographical Information Systems (GIS), they risk falling into the same trap: focusing on a specific need or requirement, often in response to funding such as that currently being provided to support bioterrorism efforts. Without guidance, local health departments are likely to repeat the experience of the business world. The author has developed such guidance for GIS in the form of foundation data, model processes, and sample applications.

With this model infrastructure, LHDs can select relevant sections to design GIS applications that build on existing GIS efforts. Such applications are more likely to be scalable and able to be integrated with future requirements, as opposed to discrete systems that require costly modifications.

The model is based on the current requirements of seven health departments in Connecticut.

INTRODUCTION

Geographic Information Systems (GIS) allow integration of information about places. Health information, particularly that collected and/or used by Local Health Departments (LHDs), often deals with place. For example, LHDs may ask *where* are septic systems failing?, *where* are children exposed to lead paint?, *where* is the source of bacterial contamination?, etc.

Given this connection of local health information and place, GIS have the potential to improve LHD productivity by allowing analysis and communication of data collected in the course of normal operations. Unfortunately, the move towards implementing GIS for local health is off to a slow start. Ten years after a Presidential Executive Order to implement GIS, LHDs in Connecticut perceive potential in GIS, but most do not have a clear idea of what that potential means in detail, and have even less of an idea of how to realize whatever that potential is.

One way to bridge the gap between promise and practice is to change the focus. LHDs should not care about implementing GIS. LHDs should care about doing their job effectively and efficiently. Therefore, success of GIS implantation should be defined as GIS helping to improve effectiveness and efficiency. Such success would have the additional benefit of freeing capacity to apply to underserved or new areas.

The key hypothesis of this thesis is that LHDs can make use of GIS without developing extensive GIS expertise, provided that GIS expertise exists in other agencies within LHD's jurisdiction. This hypothesis implies that the key requirements for GIS use in an LHD are: intermediate skill with typical office

software (e.g., Microsoft Office), curiosity, and management—*not* geographic or GIS expertise.

The hypothesis is tested from several perspectives. “Background and Significance” presents the promise of GIS in local health as described in the literature, including examples of GIS projects in local health organizations nationally and internationally. The components necessary to establish a sustainable capability are also described in this section. These components compose the author’s definition of infrastructure.

“Research Design and Methods” introduces the interviews conducted, the survey administered, and the pilot projects conducted. The selection process for interview subjects, survey participants, and pilot projects is described. This section continues to discuss the key findings from the interviews and surveys, as well as details of each pilot project.

The key findings, lessons learned, and recommendations of the overall project are presented in “Results.” This section describes how the specific aims were met and provides direction to LHDs to enable them to become self-sufficient in applying GIS.

The accompanying CD-ROM, containing the results of the pilot projects and other documentation to assist LHDs with conducting additional projects, is a key deliverable (see Appendix D for contents). The Connecticut Association of Directors of Health will distribute the CD to its membership for their reference and use on future GIS projects of their own.

Specific Aims

The research methods are designed to meet the specific aims of this project, which test the overall hypothesis and produce examples for LHDs to apply in their own contexts.

The first step in testing the hypothesis is to validate that LHDs are both interested and in need of GIS. Information gathered from the literature review and the survey provide this validation.

To validate the approach of implementing GIS in LHDs without developing significant GIS expertise, pilot projects addressing a variety of needs in a variety of LHDs were conducted.

The results of these projects, including foundation data, were provided on CD to directors of health in Connecticut.

Through the literature review, interviews, and pilot projects, confidentiality issues were identified, and recommendations for addressing these issues were provided.

In process of assembling foundation data, the quality of the available data was assessed and recommendations for improving the quality were provided.

As with data quality, the process of assembling foundation data depends on the availability of data. Availability was assessed, and recommendations for improving availability were provided.

BACKGROUND AND SIGNIFICANCE

Cromley and McLafferty define Geographical Information Systems (GIS) as “...computer-based systems for analyzing and integrating geographic data.” (1). This simple definition takes on different meanings in different contexts. The same authors attribute the variability of meanings to the nature of GIS: “In part because GIS is an enabling technology, a consensus definition has been difficult to achieve.” (1) This thesis will focus on the enabling capacity of GIS within the context of local health. We will demonstrate the ability of local health departments (LHDs) to integrate and analyze existing public health data with available geographic data without the need to develop extensive GIS expertise.

This premise may appear to suffer from the same naïve commitment to unproven concepts that often accompany calls to implement new technology. However, experience with GIS over the last several years has demonstrated that there is at least potential in the technology for local health applications. The *Journal of Public Health Management and Practice* devoted two full issues to GIS and public health in 1999 (2-8, 9-18), the *Annual Review of Public Health* conducted a “mini-symposium” on the subject in 2003 (19-23), and *Public Health Reports* carried a series of articles in 2003 (24-27).

This recent focus addresses the potential of GIS for public health and gives some demonstration of real GIS applications. The examples tend to be specific instances of large-scale university and/or federally funded studies of a specific popular cause, rather than of how an LHD can develop a sustainable capability to address operational needs and to communicate results and needs to other agencies at

the local, state, and federal level. This thesis will examine the gap between promise and implementations, and will provide model infrastructure to enable sustainable capability in the form of tailored foundation GIS data along with guidelines, examples, and templates derived from pilot projects conducted by LHDs.

The Promise

The consensus in the literature is that GIS holds great promise for public health at all levels of government. Cromley and McLafferty give some guidance on application, but the context is so broad and the rate of change in the state of the practice is so great that it is difficult to produce something useful with specificity for a local public health official (1). Roper and Mays describe the potential benefits of GIS with respect to program evaluation and public health resource allocation, but are also short on specific guidance (2). Melnick and Fleming do a service by reminding us that none of this is new: John Snow and the England General Board of Health came to different conclusions about the 1854 cholera epidemic in London using the same maps. We must take care to recognize our biases and not use visualization as a substitute for analytic discipline (3).

We do have examples of local application. Rogers gives specific examples of projects including: birth, deaths, and reportable disease; childhood lead poisoning, pedestrian traffic accidents, evaluation of surveillance data from health care providers, and evaluating accessibility of health care facilities by a variety of populations (11). Bouton and Fraser, of the National Association of County and City Health Officials (NACCHO), give specific case studies of successful LHD GIS applications. While this is encouraging, the authors go on to say that replication of

these successes requires substantial investment in human and financial resources.

They estimate that every LHD will be GIS-enabled--by 2010 (12)! How promising can a technology be if enablement requires ten years? Thrall supports this idea of delay with a series of promising applications that evolve from the example of the retail industries use of GIS to analyze potential facility locations. (18). Thrall proposes a national research agenda to achieve LHD GIS-enablement by the early 21st century.

Rushton explains the delay by the state of the technology (19). Considering GIS application hierarchically in an isolated public health context, he sees a downward push from the federal through the state level to the local level. Further, the burden of data aggregation and analysis, and of prioritizing GIS for analysis against other mandates, is on the local departments. On the other hand, Ricketts states that both GIS and their use in analysis have become widespread (20). However, Ricketts cautions against misuse and misrepresentation, indicating that LHDs should invest in developing GIS expertise during the delay in implementing the technology.

The tendency to mistrust practitioners is eloquently debunked by Cromley, who acknowledges that "Some GIS applications have not only linked hazards, exposure, and outcomes, but have taken the final step toward intervention to address health problems." Further, there are most likely many routine GIS analyses by a variety of professionals that have not been published because the use of GIS in public health practice is maturing (21). There are examples of effective use of GIS in studies that

range from carcinogens in wells in Maryland to environmental injustice in specific locations.

Another aspect of GIS that potentially limits implementation is availability of data. Cromley cites the classification of some biohazard data as one response to the events of 11 September 2001 as an example of such a limitation. McLafferty comments that the same events have made the sharing of health data in general, and data that can be geocoded in particular, much more prevalent. McLafferty notes that other countries (the United Kingdom, for example) are well ahead of the United States in this regard.

Fortunately, we can evaluate the differing opinions on the breadth of GIS use and the prognosis for universal application in the light of survey data. The *2003 Survey on the use of GIS Technology in Local Governments* (29) reveals that while 70% of respondents apply GIS for property tax reasons, only 38% report use in public health areas. Not surprisingly, use is greater in larger municipalities. That is not universal use, but it is a significant start. The survey also reports significant inter-agency data sharing (42%). Given that *Healthy People 2010* has a target of 90 percent of major national, state, and local health data systems will have records geocoded to street address or latitude and longitude in 2010 (double the 2000 percentage) (31), we can expect steady improvement in the number of LHDs both having and using this data.

Existing Examples

With all this promise, it would be reasonable to assume that there would be accelerating examples of use. There is some guidance on use. McLafferty and

Cromley provide a basic process: get foundation data, capture health data, link the databases, and decide what you want to show (7). It is the contention in this thesis that foundation data exists (LHDs need direction to it, not to search for it), that LHDs capture health data as a result of normal operations (what they need is to consider the possibilities of that data in a GIS context), that linking the databases can be done in conjunction with other agencies that already have GIS skills, and that deciding what to show is really a question of asking what problem the LHD wishes to solve. Much of this process deals with what Devasundaram terms “...tedious database management functions.” (5) The latter author describes a web-based application, sponsored at the state level (Maryland), for use by LHDs. These two proponents of GIS use illustrate the breadth of the problem of GIS implementation, particularly for a single agency at the local level.

Effective GIS applications require more than some software and a user.

Examples of effective applications include:

- location of raccoon rabies cases to identify prospective sites for bait containing vaccine (4)

- analysis of accident reports to locate sites with greater incidence of fatality (11)

- location and analysis of septic failures (12)

- evaluation of sources of childhood lead poisoning (13, 24)

- optimization of ambulance response time (30)

- analysis of impact of proposed land uses to wellhead protection areas (32)

- analysis of populations of breast cancer patients (34)

- analysis of potential sources of water pollution (35)

evaluation of the distribution of Hepatitis C cases (36)

identification of areas with greater susceptibility to traffic air pollution (37)

planning for the location of health facilities (43)

These examples indicate that effective GIS use is possible. Examples of the nurturing required to support success include:

President Clinton's Executive Order on spatial data, initiating the National Spatial Data Infrastructure (NSDI) (9, 42)

Spatial data that is available from a variety of sources (10)

Available software such as *Community 2020*, developed by the US Department of Housing and Urban Development (HUD) (14) or *EpiMap* developed by the Centers for Disease Control and Prevention (CDC) (15)

Commitment at state (e.g., Maryland, 5) and county (e.g., DeKalb County, Georgia, 11) levels to GIS use in government agencies

This support enables effective management of programs using GIS. Examples include state-level monitoring of LHD use (17) and the proactive application of GIS in local health situations (27). It also allows evolution into unexpected advantageous use (28, 33). Still, as with any technology, GIS is subject to error in specific situations (38) and misuse or misinterpretation (39, 40).

As mentioned above, there are most likely many uses of GIS at the local health level that do not make it into the journals. The response to the survey of local health officials in Connecticut that will be described in detail in the "Data Collection" subsection of "Research Design and Methods" and is presented in Appendix C reveals that 63% (n=22) have made no use of GIS, and 11% (n=4) have

used GIS on more than 5 projects. There are two messages from these results: a significant minority is attempting to apply the technology, but very few are making significant progress towards institutionalization. This pattern is consistent with the literature—individual agencies may make progress through the tedium referenced by Devasundaram (5) when broad support is available, but if such support is absent or one or more of its components are withdrawn, successes are inconsistent.

The Gap

Common features of the successes referenced above include available data, access to software, a defined goal, and trained personnel. The problem with specific successes is that they often are not sustainable, because the data, the software, the goal and/or the personnel move on to the next project, leaving no means to build upon the success. These elements are key components of an institutionalized information infrastructure, without which no capability such as GIS application can be sustainable.

Information infrastructure definition

The author defines an information infrastructure as the organizational components required for institutionalization. An excellent example of these components is described by the Software Engineering Institute (SEI) in the Generic Practices required for a Managed Process in the Capability Maturity Model Integration (CMMI) (44). The CMMI is an Information Technology (IT) industry standard model against which organizational process maturity are appraised. Note that this is an appraisal of how organizations are managed to apply technology, not

of the technology itself, and that this robust model is applicable in a variety of contexts, including this one.

The practices are:

Establish an Organizational Policy

In order to communicate what people are expected to do, and what the organization expects to accomplish, written policies are mandatory. In the context of this thesis, people should not have to ask whether GIS will be used if the LHD has a documented policy that GIS will be used wherever appropriate and that LHD personnel will assess the applicability of GIS to every work effort.

Plan the Process

The overall GIS program must be planned. The plan describes how the policy will be implemented, including the tasks to be accomplished, the schedule, and the roles (not people) to be assigned to each task.

Provide resources

The plan will describe the need for personnel, hardware, software, training, and other program components, and the funding to procure these components.

Assign Responsibility

Responsibility for the program must reside in one individual who will provide overall governance. In addition, each role in the plan must be assigned to personnel.

Train People

Part of planning is determining what training is needed, who needs it, and what the alternatives for delivery are. The training plan, including associated funding, must be part of initial program development.

Manage Configurations

Configuration Management involves storing and controlling maps, map documents, and spatial data—and changes thereto. Since GIS applications are often iterative processes with frequent changes updated by a variety of people, this practice is a key component of effective GIS use.

Identify and Involve Relevant Stakeholders

This practice involves determining who is affected by GIS use in general and on specific projects, and developing a plan for involving those individuals or organizations in the GIS program.

Monitor and Control the Process

Basic project management and program management disciplines must be applied. These disciplines include regularly assessing the status of deliverables and budget to determine variances and taking corrective actions where necessary.

Objectively Evaluate Adherence

A healthy, effective organization has standards for project and program performance, and standard processes to follow. Every work effort should be reviewed periodically to determine what deviations there have been and if improvements are required in processes and/or practitioners.

Review Status with Higher Level Management

In a Connecticut local health context, this means providing municipal governments or district boards of directors with regular reports of progress on GIS implementation.

Gap between current state and the definition

The current state fails to meet the test of the first practice—establish a policy. While there have been broad commitments such as the creation of the NSDI, and the National Map (41), these have suffered when it comes to implementing something that is meaningful for practitioners. The National Map is a good name, but is nothing more than a set of pointers to work that has been done (or not) at state and local levels.

At the LHD level, having a policy means committing the organization to the use of technology to solve problems that can be solved. This is different from conducting a study and declaring victory. It is a management practice that results from understanding what is possible and what value the possibility hold for the ongoing operation of the LHD. If the value does not exceed the cost, do not do it. However, without a commitment, neither the value nor the cost will be understood.

As Connecticut local health fails to pass the first test, discussion of the rest of the practices is not necessary at this point. See Appendix B for sample practices tailored for LHDs in Connecticut. Key inhibitors to furthering GIS in this group are resources (staff and funding), and training (funding, availability, and availability of staff to undergo it). Most of the other practices are management considerations that have solutions. However, the issue of stakeholders has particular significance in a range of contexts. For example, residents of towns are stakeholders with respect to privacy: is it appropriate to identify addresses where certain environmental conditions exist or where residents suffer from certain health conditions, and to make that information available to anyone with an internet connection? Other

stakeholders include suppliers of GIS data and those who are interested in data generated by GIS efforts by LHDs. These could include government or academic researchers, residents who have privacy concerns, and other agencies, within and external to the LHD's jurisdiction.

The set of CMMI Generic Practices is an example that provides useful guidance on whether to implement GIS, and, if implementation is attempted, what needs to be done to assure success. It also provides a tool for evaluation of implementations. The evidence observed to this point indicates that we need to do better—at least in the case of LHDs in Connecticut.

RESEARCH DESIGN AND METHODS

Data for this thesis was gathered through three primary methods: interviews, a structures survey, and pilot projects. This section describes the means of selecting subjects for each of these methods, the process by which each was conducted, and the key findings and/or results of each individual method. The overall analysis and aggregation of results are presented in the following section (“Results”).

Subjects

Interviewees

Interviewees were selected from people known to the author on the basis of their knowledge of and/or interest in local health or GIS.

Survey participants

Surveys were distributed to the members of the Connecticut Association of Directors of Health (CADH). The CADH membership of 73 includes all full-time health departments and health districts, and 16 of the 35 part-time health departments. One set was distributed at the monthly membership meeting in August, 2004, and additional surveys were mailed to members not attending the meeting. Participation was voluntary. Approximately 50% of the membership responded.

Table 1 shows some of the survey results. The columns give the following data:

- Type of LHD – as defined by the State of Connecticut
- Number – the number of each type of LHD responding
- Towns – the number of towns covered by the LHDs responding (e.g., 15 districts covering 83 towns responded)

- % CT Population – the percent of total state population represented by the towns covered by the type of LHD (e.g., the 83 towns covered by the 15 health districts responding cover 35% of the state population)
- GIS Users – the number of respondents that have conducted three or more GIS projects (less than 3 does not yet represent a serious enough commitment to be classified as a user)
- Access to other agency GIS – the number of respondents indicating that at least one agency in at least one town in the jurisdiction has an operational GIS capability.

The 36 respondents cover 64% of the population of the state.

| Type of LHD | Number | Towns | % CT Population | GIS Users | Access to Other Agency GIS |
|-------------|--------|-------|-----------------|-----------|----------------------------|
| District | 15 | 83 | 35% | 1 | 10 |
| Full-time | 18 | 17 | 28% | 3 | 14 |
| Part-time | 3 | 3 | 1% | 1 | 1 |
| Total | 36 | 103 | 64% | 5 | 25 |
| Percent | | | | 14% | 69% |

Table 1: Respondents to CADH Survey

Pilot projects

Selection

Sixty-three (63) percent (n=22) of the survey respondents indicated interest in participating in a pilot project. In follow-up communication, the pilot selection criteria were presented to the directors of health: an operational GIS capability within the jurisdiction, use of ESRI software, definition of a project that would be of value to the health jurisdiction. Seven health departments retained their interest

after analysis of the criteria, and all seven were accepted. (See Figure 1 for locations.) The most important criterion was the last: the LHD must have a project that would produce something of value to the director and to the community.

Projects

1. Analysis of hazardous spills in the Northeast District (CT) Department of Health (NHHD) for prevention and remediation
2. Analysis of septic failures in Southington, CT relative to existing and planned sewer lines as input to town policy and regulatory processes
3. Analysis of septic failures in Norwalk, CT relative to existing and planned sewer lines as input to town policy and regulatory processes
4. Analysis of septic systems, private wells, and bacterial tests in East Haddam, CT (Chatham Health District) with respect to bacterial measurements in nearby recreational water bodies
5. Lead hazard control operations and vulnerable populations in East Hartford, CT
6. Lead hazard control operations and vulnerable populations in Waterbury, CT
7. Location of septic systems in Middlebury, CT relative to existing and planned sewer lines as input to town policy and regulatory processes

Project Plan

The researcher created a project plan as a Microsoft Project template, based on actual experience. This template serves as an overview of each of the projects and also as a model to be adapted for use by any organization wishing to execute a GIS pilot project. The hypothetical start date is Monday, January 3 2005. The ten week duration corresponds approximately to actual timing. The plan includes basic tasks,

durations, dependencies, and resources required. Actual projects will differ based on specific requirements, but the template summarizes the activities and personnel in each of the seven pilot projects described herein. A Gantt chart view of the plan is shown in Figure 2.

This plan is also provided in softcopy as a Microsoft Project template (.mst file) on the accompanying CD-ROM. A more detailed view of the project showing tasks, schedule, resources, and assignments of resources to tasks is also included as an Adobe Portable Document Format (.pdf file). For those who do not use Project, the CD also includes a .pdf version of the Gantt chart view in Figure 2

Hardware/Software Configuration

The GIS component of the pilot projects was conducted by the researcher using datasets that were provided by the participants (see specific project descriptions), available on various web sites, and/or were manipulated by the researcher. The following software products were used on an IBM ThinkPad Model R40 (2897-B4U) with 1.4Ghz Pentium M processor, 768MB RAM, and a 34GB hard drive, running Microsoft Windows XP Professional Edition SP2:

- Microsoft Office XP Professional (for Access and Excel)
- Microsoft Project 2000
- Adobe Acrobat Version 6.0
- ESRI ArcGIS Desktop Version 9.0 with 3D Analyst, Geostatistical Analyst, Publisher, and Spatial Analyst extensions

Not all participants had software at the same levels as the researcher. For example, all had earlier versions of the ESRI product set, and some had earlier

versions of Office. The researcher encountered no conflicts due to software versions, either in receiving data from the pilot participants or in providing data to them.

Data Collection

Interviewing

Key informant interviews

Jennifer Kertanis, Director, Connecticut Association of Directors of Health

Karen Spargo, Director of Health, Naugatuck Valley Health District

Ryan Grenon, Director of Health, Clinton, CT

Steven Mansfield, Director of Environmental Health, Ledge Light Health

District

Mary Jane Engle, Sanitarian, Town of Westbrook Health Department

Neal Lustig, Director of Health, Pomperaug Health District

Timothy Dupuis, Engineer, Camp, Drexel, and McGee

In-depth interviews

Paul Frenault, Geographer, Weston-Westport Health District

Patricia Beckenhaupt, Director of Health, Northeast District Department of

Health

Joseph DeMayo, MD, Director of Health, and Rose Wright, Waterbury

Department of Health

Charles Motes, Director of Health, Southington Department of Health

Key Findings from Interviews

The objectives of the key informant and in-depth interviews was to validate the basic premise that GIS is perceived to have value and that cooperation with other departments has the potential for success, and to understand the varieties of organization within the various health jurisdictions. Key findings were:

1. The variety of organizational structures make the definition of a consistent approach difficult

Connecticut has 31 full-time health departments serving municipalities ranging in population from 13,000 to 140,000, 19 health districts serving from 1 to 17 municipalities with combined populations of 25,000 to 155,000, and 46 part-time health departments serving municipalities with populations of 1,500 to 29,000 (45). In addition, there are two tribal nation health departments serving populations that are disbursed among the preceding figures (Keri Gilford, Connecticut Association of Directors of Health, personal communication, August 2004). The needs of diverse populations are served in diverse ways by diverse structures. Approaches to technology implementation will have to recognize and accommodate this diversity.

2. Local health departments collect and maintain data with geographic dimensions

From the location of populations the present difficulty in delivering services such as immunization to the location of failing septic systems, almost all LHD data has answers to “where” questions.

3. Many health departments have limited access to information technology

There are two problems here: first, smaller towns usually segment their responsibilities so that health officials have neither expertise nor accessibility to

other departments' information and, second, health districts include towns that are in differing states of maturity with respect to information technology

4. There is a tendency to rely on heroes

Where projects involving GIS have succeeded, the success has relied on the expertise and/or leadership of specific individuals. When the individual leaves his or her current role, the GIS success travels with him. This makes establishing and maintaining a capability very difficult.

Structured survey

A survey on GIS awareness, needs, and capability was conducted with the Connecticut Association of Directors of Health. See Appendix C for questions and summary of responses.

Key Findings from Survey

1. Access to GIS has not translated to GIS use

Sixty-nine (69) percent of respondents report that GIS is operational in at least one department in their jurisdictions. However, if use on more than two projects as an indication of a minimally sustained commitment, only 14% (n=5) qualify. This finding is significant, as it is the gap between the 14% who use GIS and the 69% who have access to GIS that this thesis is attempting to address.

2. Initial attempts at GIS projects have covered a variety of subject areas

For mapping, monitoring of septic systems is the dominant use at 57% of respondents, but there are a variety of other mapping efforts. The diversity is greater for events, with testing of birds for West Nile Virus (WNV) the leader with 43%, but several other uses have also been attempted.

3. LHDs that have attempted GIS projects have done so primarily because they recognized the value of GIS

Either by itself or in combination with other responses, 100% said they used GIS because they recognized the value, indicating that there is motivation that can be converted to action with support.

4. Training and time are greater obstacles to GIS implementation than financial considerations

Seventy-four (74) percent of respondents perceived obstacles to GIS use, and 81% responded that training and time were obstacles. Funding was third with 62%. Considering that the previous response regarding value, this may be an indication that directors of health recognize that the return on investment in training and time can counter financial considerations.

5. Infrastructure is identified as the key to GIS implementation

Responses to the questions regarding infrastructure demonstrate a clear desire for support, including planning and direction and hardware/software (66% each) and a starter set of data (63%). This is an indication that Connecticut directors of health believe that they could be successful with GIS given a starting point and a clear direction.

Pilot projects

Analysis of hazardous spills in the Northeast District (CT) Department of Health (NHHD) for prevention and remediation

1. Objective

To identify areas of frequent spills for potential preventive action, evaluate common types of spills to understand facilities (schools, medical facilities, sources of drinking water, etc.) that may be vulnerable, and to identify organizations that experience frequent spills.

2. Description

When a spill occurs, local authorities notify the Connecticut Department of Environmental Protection (DEP), which faxes notification to local health department (in this case-- in other jurisdictions, the notification may go to another department, such as the zoning enforcement officer). NDDH records these events in a Microsoft Access database. The original intent for the database was the same as this project's objectives. GIS capability enriches that intent project by enabling visual analysis and communication.

3. Results

The Northeast District Department of Health serves 12 towns in the northeast corner of Connecticut. The total population served is 79,023, with individual town populations ranging from 693 to 16,472 (2000 census).

At an initial meeting involving the town planners from the towns of Killingly and Plainfield, the Director of Health, and the researcher, the project was discussed

and scoped. The town planners were skeptical that their GIS data would be of any use to the project. NDDH provided the database of spills to the researcher.

The database contained records of 593 spills that occurred between October, 1996 and August, 2004. Only 245 of the 593 were plotted on a map using address match geocoding, even after data analysis and cleansing (correcting spelling, finding alternate road names, finding addresses for locations given as places, etc.). Reasons for the low degree of matching include the rural nature of much of the Northeast District, where specific addresses are not always available, and the size of the district, as roads may change names as they pass through the twelve towns. Also, attention was not given to address specificity, as the database was not conceived for that purpose.

After geocoding as many spills as possible, the researcher added data available from other sources.

| Layer | Source | Comment |
|--------------------------|----------------------------|--|
| Town Boundaries | DEP Web Site (46): Towns | Clipped for NDDH, labeled on TOWN |
| Spills for Display | NDDH Spill database | Cleansed address data to extent possible, geocoded via address matching, interpreted values in "RELEASE_TY" column for spelling and other duplicates to reduce the number of values into "SPILL" column, symbolized on SPILL |
| Roads | DEP Web Site: NamedStreets | Clipped for NDDH, labeled on FENAME, displayed only at scale 1:100000 and below (large scale example) |
| Highways | DEP Web Site: Routes | Clipped for NDDH, labeled on empty Routename column, which was updated with route number prefixed by CT for state, US, or I- for interstate |
| Orthographic Photographs | DEP Web Site | Used quadrangles that contain the twelve NDDH towns. The example in Figure 4 uses the Putnam Quadrangle, Southeast Quadrant; oq0028se (large scale example) |
| Water Source Data | DPH | Restricted data |

Table 2: GIS layers added for NDDH project

The water source data presented a challenge. This data is exempted from the Freedom of Information Act by Connecticut statute. The Connecticut Department of Public Health (DPH), which owns the data, did not yet have a policy for releasing the data (Tyler Kleykamp, DPH, personal communication, September, 2004). After discussion with officials of a local water company, the Director of Health went back

to DPH to request access to the data. DPH completed development of a policy, under which the Director of Health traveled to DPH offices in Hartford to take personal receipt of the data on CD. The CD, titled “2004 Drinking Water Geospatial Datasets,” contained only data for the 12 towns of the Northeast District. A condition of receipt was the Director of Health signing of a document stating that the data was confidential and would not be shared beyond the Health District. As an agent of the District, the researcher was authorized to receive the data. For security reasons, the data was only exchanged person-to-person. Electronic distribution and/or couriers were deemed to be less secure.

The resulting map, without the restricted DPH data is shown in Figure 3. The static map is useful for a high-level overview. For example, it demonstrates that the majority of spills occur along the Interstate Route 395 (I-395) / Connecticut Route 12 (CT12) corridor. To be useful for analysis, the Department of Health should use software such as ArcExplorer or ArcReader to view the map interactively at various scales, and to produce specific local maps for areas where maps action may be required.

Figure 4 provides an example of the same map at larger scale. Additional data that is not possible to include at smaller scale is provided. For example, it is not possible to interpret orthographic photos at the scale required to display the entire district, and local roads cloud small scale maps but are useful to view at the larger scale. This example shows facilities that report toxic releases to EPA (yellow dots) and nearby spills reported to DEP (red dots). Further analysis will determine if the spills are related to the facilities. This is exactly the kind of information that could

be useful to the Department of Health if the procedures and skills are in place to do the analysis.

4. Next Steps

a. Cleanse and organize the spill data

To the extent possible, NDDH should review existing data regarding spill locations, media, and responsible parties to assure that they are correct and consistent. If necessary, geographic locations should be identified by latitude and longitude. In addition, the database should be reorganized according to basic database design principles. For example, discrete tables should be established for events and for responsible parties, and reference tables for media and street names should be established for ease of entry and for error reduction.

b. Request that DEP provide map coordinates with each spill report

This change in the DEP reporting process would simplify recording and analyzing spill data. DEP could provide latitude and longitude coordinates for each spill.

c. Evaluate the project results

Given the results of this project and the effort required to continue operation, NDDH should consider if the value returned, and potential value from additional projects, warrants the cost in terms of the time and personnel required to establish a sustainable capability

d. Establish procedures for recording spill data

If this application is to be useful over time, NDDH should establish a procedure for recording each spill event, and for assuring that the data was entered, and entered properly.

e. Develop processes for updating relevant data

The base data represented in Table 2 includes facilities that may change. For example, schools may be added or closed. The results of this project should be considered dynamic, and NDDH should consider appropriate time frames and responsible parties for updating these data. A GIS specialist in one of the towns in the jurisdiction or in the Council of Governments (COG) will need to update the GIS dataset with additional spill data.

Analysis of septic failures in Southington, CT relative to existing and planned sewer lines as input to town policy and regulatory processes

1. Objective

To identify areas of septic failures, as indicated by repair permits, and determine if there are existing sewer lines to which homes could be connected or to demonstrate to the town planning authorities where sewers should be extended

2. Description

Southington, CT is a city of 39,728 (2000 census). The public works department has an operational GIS system and an engineering firm that maintains town-specific GIS data. The Director of Health was interested in assuring that specific data on septic failures was included in the planning process for sewer extensions.

3. Results

The Director of Health provided a spreadsheet with 1572 septic permit records. Address match geocoding was very effective. After changing community names (Plantsville, Marion, etc.) to the city name (Southington), the effective matching rate was 86%. The remaining streets were either in newer areas of Southington where the roads were not in the address matching file, or had spellings that differed from the service.

The engineering firm provided land parcel and sewer line GIS files.

Table 3 shows the data used in the overview map. The resulting map was plotted on 30" by 40" paper and presented to the Board of Selectmen. The map (see Figure 5) resides in the First Selectman's office.

| Layer | Source | Comment |
|--------------------------|--|--|
| Town Boundaries | DEP Web Site: Towns | Clipped for Southington |
| Roads | DEP Web Site: NamedStreets | Clipped for Southington |
| Parcels | Brodie Group (engineering firm) | Visible below 1:30,000 |
| Sewer Lines | Brodie Group (engineering firm) | |
| Soil Types | DEP Web Site: WetlandSoils | Clipped for Southington, symbolized dominant soil types |
| Ground Water Quality | DEP Web Site: GroundWaterQualityClass | Clipped for Southington, only showed GB (Treatment Required) |
| Aquifer Protection Areas | DEP Web Site: APA | Clipped for Southington |

Table 3: GIS layers added for Southington project

4. Next Steps

a. Integrate the results of this project into normal town operations

Once the map was printed, this project became obsolete. To sustain the value, Southington should set a schedule (e.g., quarterly) by which the septic table in the GIS dataset is updated, newly added addresses are geocoded, and the map is updated. On a quarterly basis (for example) the Director of Health could analyze the additional data on-line to see if any additional problem areas have arisen, and take action if that is the case. On an annual basis, the hardcopy map could be produced as an update for town authorities (Selectmen, Water Pollution Control Authority, etc.).

b. Evaluate parcel data as an alternative to address matching

The parcel data did not enter this project until late in the process. Since the attribute table for the parcels contains street addresses, it may be possible to join the parcel table to the septic permit table. This would yield a more precise result that may be more meaningful to Southington officials and residents.

Analysis of septic failures in Norwalk, CT relative to existing and planned sewer lines as input to town policy and regulatory processes

1. Objective

Similar to Southington, Norwalk was interested in identifying areas of septic failures for sewer service planning. In addition, the Norwalk Director of Health was interested in personnel planning for the four sanitarians: the location of septic systems, and of concentrations of problem systems, could help assign areas of town to each sanitarian.

2. Description

Norwalk is a city of 82,951 (2000 census). The Health Department has an IT director who interacts with the town's IT Department. The town has an operational GIS capability under the primary responsibility of the Department of Public Works.

3. Results

The Health Department provided an extract from their septic permit database with 6,399 records. Department of Public Works provided GIS datasets containing 22,393 land parcels and tax assessor records. The latter were used both to identify parcels and to determine sewer service areas, under the assumption that residents in districts where sewer tax is assessed have sewer service and those that live in other districts do not have service. There may be some anomalies in the records, and some records did not have valid district codes, but this assumption is sufficient to identify areas of sewer service.

The septic permit data was analyzed. The dates of activity ranged from 1924-2003. Several records had invalid dates (e.g., future years). 188 records had missing or invalid dates. 175 had blank application types (new/addition/repair), and were assumed to be something other than repair. After discussion with the director of health, the researcher limited the file to activity within the last 10 years, and eliminated the records with blank application types from the analysis. The remaining 852 records were geocoded by address matching, with 100% success. Of those, 102 had repair applications in the 10-year period.

The septic data was then added to a map with additional GIS data from the Department of Public Works and from other sources identified by the researcher as

shown in Table 4. Figure 6 shows a section of the map produced zoomed to 1:14,485 to illustrate septic activity and sewer service areas in one portion of the town.

| Layer | Source | Comment |
|--------------------|------------------------------------|---|
| Town Boundaries | DEP Web Site: Towns | Clipped for Norwalk |
| Roads | DEP Web Site: NamedStreets | Clipped for Norwalk |
| Septic Activity | Norwalk Health Department | Spreadsheet extracted from database, address match geocoded, last 10 years extracted, symbolized on APPTYPE |
| Assessor Data | Norwalk Department of Public Works | Parcels visible below 1:50,000 SEWER_CODE Column added to indicate sewer service or not, symbolized on SEWER_CODE |
| Municipal Property | DEP Web Site: MunicipalProperty | Clipped for Norwalk, symbolized by type of building |

Table 4: GIS layers added for Norwalk project

4. Next Steps

a. Data Cleansing

The tax assessor data was very clean with respect to addresses. As with Southington, it may be useful to eliminate the address matching by joining the septic application data to the assessor data, and symbolizing repairs from the joined

table. In any case, both the septic data and tax assessor data should be reviewed for possible update of blank and invalid data.

b. Institutionalization

Norwalk demonstrates significant maturity with respect to its use of GIS in particular and IT in general. For example, the ease of address matching was impressive, indicating that data validation and data entry procedures are operating well. As the health department moves forward with GIS, the objective should be to integrate anything with a geographic dimension into the GIS system. To facilitate this objective, the department should construct an inventory list of GIS datasets in use by the city with a description of associated attribute tables. This list should then be evaluated for relevance to Health Department data, and procedures should be developed to integrate the Health Department data with the GIS data on a regular basis. For example, the septic permit data could be joined to the tax assessor data on a regular (e.g., quarterly) basis to create a current GIS layer that could be used in mapping applications. This process could include removing older records in addition to adding new ones. That is, if a ten-year period is desired, records older than 10 years could be dropped in each update cycle.

Analysis of septic systems, private wells, and bacterial tests in East Haddam, CT (Chatham Health District) with respect to bacterial measurements in nearby recreational water bodies

1. Objective

To track the condition and repair activity of septic systems and private wells in areas near three lakes in East Haddam, for possible correlation with bacterial contamination in the lakes.

2. Description

The Director of Health in the Chatham Health district proposed a project that would combine data from multiple state, municipal, and private sources to assist with analysis of current land use and impact on water quality as input to decision-making processes.

The Chatham Health District comprises 5 towns in East Central Connecticut, an area of significant seasonal population attracted by recreational lakes. Lake Hayward, a 172 acre lake in East Haddam (population 8,333 according to the 2000 census), experienced an *Escherichia coli* (*E.coli*) contamination event in 1999. The East Haddam Lakes Property Owners Association, which represents owners of mainly seasonal property around three lakes including Lake Hayward, took action to assess the possible sources of contamination to determine:

- Whether or not there is a problem
- Whether or not there are potential future problems
- What monitoring actions may be required (and where)
- What remedial actions may be required (and where)

The actions began with a survey of homeowners to collect information on the type, age, and condition of septic systems and wells, the size of the property, and the age and size of the dwelling. Concurrently, a Lake Association volunteer began to take regular water samples for bacterial testing at locations identified using a hand-held Global Positioning System (GPS) device.

3. Results

The pilot project addressed the condition of one pilot area on one of the lakes. The Director of Health will use this information in an application for grant funding to establish the capability for all lakes, and to set the foundation for applying the same principles in other towns in the district.

The Town of East Haddam Land Use Department provided GIS datasets that identified land parcels, which could be matched to property attributes in spreadsheets containing results of the property owner survey using map and lot. One challenge in matching was that the town was in the process of converting lot numbers to a new format. The association data used the current format, but the town data used the new format. To facilitate conversion when the town finalizes the process, the town created an additional attribute named “unique identifier” (UID).

The Land Use Department was able to provide an interface file that contained UID, Property Owner Name, Street Number, Street Name, and a combined Map and Lot Number field, prefixed by “M” and separated by a hyphen. The researcher manipulated this combined field to produce a six-character numeric property identification field (PID) containing the three-character map number with leading

zeroes (where necessary) and no “M” prefix, concatenated with a three-character lot number (with leading zeroes added and extraneous trailing characters deleted). The extraneous trailing characters were related to the reason for the map and lot number change: they were the old way to accommodate parcels that had been combined and/or split over the years, and had become unwieldy in the age of computers.

The only identifying attributes in the association spreadsheet were map and lot numbers (old format). The researcher created a PID field in the spreadsheet by adding leading zeroes where necessary and concatenating the fields.

The two resulting Excel spreadsheets contained data sufficient data for joining on the PID field. The two spreadsheets were imported as tables into an Access database. A make-table query joined the two tables on PID and created a new table with all attributes of the both source tables. The database was then saved in the project directory for inclusion in the project.

The researcher began a new map by adding the parcels polygon provided by the Land Use Department. The joined table from the database was then added to the map and joined to the parcels on UID. The parcels could then be symbolized by the association data attributes as desired.

Table 5 shows the data used to create the initial map for the pilot area, and the relationships between the various datasets.

| Layer | Source | Comment |
|---------------------|---|--|
| Lake Hayward | DEP Web Site: NamedLakes | Clipped single lake |
| Roads | DEP Web Site: NamedStreets | Clipped for East Haddam, used labels only for street names |
| Land Parcel Data | East Haddam Land Use Department | Joined to association data as described above |
| Surficial Materials | DEP Web Site: SurficialMaterials | Clipped for East Haddam, symbolized on Legend by till and thick till |
| Hydrography | DEP Web Site: hydro | Clipped for East Haddam , symbolized on Legend by type |
| Soil Types | DEP Web Site: soil | Clipped for East Haddam, symbolized on CTWET by soil type |
| Property Database | Created by researcher from manipulated association spreadsheet and manipulated Land Use Department spreadsheet as described above | Used to provide additional attributes of parcels as described above |
| Orthographic Photos | DEP Web Site: Digital Orthophoto Quarter Quadrangles | Colchester Quadrangle, Southwest Quarter; oq0070sw |
| Bacterial Tests | Association | Sampling sites geocoded with coordinates taken with handheld GPS. Test results joined to sites by site identifier. Bar charts created to show results over time at some locations. |

Table 5: GIS layers added for Chatham project

It should be noted that the lake association and town officials have taken interest in the project. The researcher was invited to make presentations of the objectives and progress of the project to the Chatham Board of Health (composed of the top

official—First Selectman or Town Manager--in each of the five towns) and to the Lake Association Board of Directors. The researcher has committed to continue to work with the association to assist with their analysis and to provide additional support.

Figure 7 illustrates properties in the pilot area. The map will be even more useful when additional information on septic systems on the properties is available, newer photographs are obtained, and additional bacterial test data is available. As presented, showing lots that are too small for the number of bedrooms (less than one-sixth of an acre per bedroom) and the results of some chemical and bacterial tests, this map is beginning to be an excellent tool for the Lake Association to analyze sources of bacterial contamination. Working with the Director of Health, they will be able to recommend actions that range from doing nothing unless/until continued monitoring indicates a problem to extending sewer lines to this area.

4. Next Steps

a. Get more data

The data provided to date represent a significant achievement. The Lake Association was proactive, and took the initiative to study the problem, analyze it, and possibly take corrective action. However, more details are needed (and are being produced as this is written).

Information is needed on more properties, and more information that is currently available in the spreadsheet is needed. The columns in the spreadsheet, representing survey responses, are sufficient. However more of the columns will need to be populated if the project is to produce the desired results.

As commendable as the volunteer effort is, a means with more clout may need to be devised if the necessary results are not obtained.

b. Improve process for matching properties to UIDs

With the small number of properties in the pilot area, the researcher was able to interpret map/lot and UID data with relative ease. This may not be possible as the project expands to an increasing number of properties. Also, individual intervention to correct UIDs hinders the replicability of the effort. The current assumption is that the map/lot conversion process will be complete before the project expands significantly, and the conversion will no longer be needed. There is a risk that this will not be the case, and alternative matching procedures may need to be devised.

c. Extend project to all of Lake Hayward

After the concept is proven with this pilot effort, the immediate next step would be to complete the data for all properties and update the map accordingly.

d. Replicate Lake Hayward process in other recreational areas

The value of this effort goes beyond Lake Hayward and beyond East Haddam. The capability developed can be replicated for many recreational areas, and the lessons learned can be applied to other situations within the district.

Lead hazard control operations and vulnerable populations in East Hartford, CT

1. Objective

To identify populations that are vulnerable to elevated levels of lead in blood by analyzing where children live, what un-remediated pre-1978 and pre-1950 housing is in those areas, and what other sources of lead exist in the vicinity.

2. Description

The Town of East Hartford, population 49,575 (2000 Census) is operating a lead-based paint hazard control program under a grant from the United States Department of Housing and Urban Development (HUD). The town has an active GIS capability that is operated by various departments with support from the IT Department. Up to this point, neither the Department of Health nor the Lead Hazard Control program had used GIS. When the researcher solicited pilot projects, East Hartford saw the value of applying GIS to the problem of lead hazard control.

After an introductory discussion with Department of Health project coordinator, a meeting was scheduled with the researcher, the project coordinator, a Housing Planning Analyst, and the IT Director. The objectives of the project were defined as developing processes and guidelines to enable the lead project to draw on existing information in a GIS application to contribute to the analysis of potential lead hazard identification.

The IT Director provided a GIS dataset, including a shapefile with land parcels as defined by the Tax Assessor's office ("Land Parcel Data" in Table 6). The attribute table for this shapefile contained only a parcel id (PID). An Access database containing tables of property attributes was also provided. Tables in this database could be joined to the shapefile attribute table on PID. One such table, "mainbldg" contained the attributes of the main building on each parcel. The researcher added a field to identify pre-1978 and pre-1950 properties before joining to the parcel shapefile.

Other relevant data included census data regarding ages of inhabitants, properties that have undergone lead hazard control (HUD no longer uses the term “remediation” as that implies a positive result), facilities that report releasing lead into the environment to the Agency for Toxic Substances and Disease Registry (ATSDR), and local information (flyover photos, water features, etc.).

3. Results

The result of combining data from multiple sources was very interesting to the lead project, and demonstrated the value of GIS for future analysis. The project coordinator requested a user guide to describe how to identify and manipulate relevant data for analysis. The Guide is included in the accompanying CD in the East Hartford project folder.

Table 6 shows the sources and uses of GIS data for this project.

Figure 8 shows an example of a small scale map, including photographs. The map illustrates older housing stock, areas with children under the age of 5, and one facility that reports releasing lead or lead compounds into the East Hartford environment.

| Layer | Source | Comment |
|---------------------------------------|--|---|
| Town Boundaries | DEP Web Site: Towns | Clipped for East Hartford |
| Roads | DEP Web Site: NamedStreets | Clipped for East Hartford, symbolized by Legend by type of road |
| Land Parcel Data | East Hartford Information Technology Department | Joined to property attribute data as described above |
| Census Block Data | ESRI Web Site (47): census blocks | Clipped for East Hartford, restricted by definition query to blocks with > 10% under age 5 and more than 5 persons under 5 (this is an example that can be adjusted according to needs) |
| Property Database | East Hartford Information Technology Department | Used to provide additional attributes of parcels as described above |
| Orthographic Photos | DEP Web Site: Digital Orthophoto Quarter Quadrangles | Manchester Quadrangle, Southwest Quarter; oq0038sw, others could also be applied (Hartford North-SE, 37se; Hartford South-NE, 52ne; and Glastonbury-NW, 53nw) |
| Facilities Releasing Toxic Substances | TOXMAP Web Site (48): facilities and releases | Reduced for Connecticut, joined spatially to East Hartford Town Shapefile, limited to facilities releasing lead or lead compounds |
| Lead Hazard Control Status | East Hartford Lead Hazard Control Program | Not available at time of printing |

Table 6: GIS layers added for East Hartford project

4. Next Steps

a. Review, approve, and implement the User Guide

The project coordinator, together with other stakeholders, should review the User Guide provided on CD, make appropriate updates, and implement as policy in the Department of Health

b. Secure additional data

The lead program will be collecting data on blood tests. The researcher specifically requested that this data not be provided, due to confidentiality concerns. However, the User Guide gives direction on how to add information on elevated blood levels to the GIS project dataset, either by address match geocoding, or by a mechanism that matches residences with parcel data.

In addition, the information on what properties have undergone lead hazard control will be very valuable in determining where vulnerable populations reside. It should be added to the project dataset when available.

c. Determine additional data requirements

The Lead Hazard Control Program will have additional questions to ask of the data. Spatial and/or attribute data to answer those questions is probably available, but the Program will need to spend time with the data and processes provided in order to determine what the questions are.

The Lead Program should also investigate the availability of more current orthographic photographs for East Hartford. The photos used in the sample map were taken in 1990, and the town may have, or may be obtaining, more current photos. These photos may be at higher resolution, so that more features are visible.

The ability to display images of buildings and surrounding areas enables analysts and citizens to relate to the project results.

d. Determine the impact of toxic releases

The ATSDR data may or may not show a potential problem. The specifics of the facilities in and near East Hartford should be investigated to determine what actions, if any, need to be taken.

Lead hazard control operations and vulnerable populations in Waterbury, CT

1. Objective

To identify populations that are vulnerable to elevated levels of lead in blood by analyzing where children live, what un-remediated pre-1978 and pre-1950 housing is in those areas, and what other sources of lead exist in the vicinity.

2. Description

The City of Waterbury, population 107,271 (2000 Census), has high rate of older housing. Eighty (80) percent of the housing was built before 1980, and 55% before 1960 (49). With over 15% of the population under 10 years old (49), there is a significant vulnerable population living in potentially hazardous locations.

Waterbury is operating a lead hazard control program under an HUD grant. As in East Hartford, the Director of Health perceives value in applying GIS technology to analyze locations and populations.

Waterbury has an operational GIS capability in the Building Department and the Public Works Department. The IT department supports the GIS application.

3. Results

The Director of Health and Assistant Director of Health worked with the researcher to define the scope of the project. For a variety of reasons, Waterbury-specific data was never produced. One main problem was that very little of the data is the responsibility of the health department.

For example, key information such as where, specifically, is the older housing, is the responsibility of the Building Department. Other key data points such as the addresses of children and the results of their blood tests belong to the lead program (as in East Hartford, this data must be restricted for confidentiality reasons). The health department would have to divert a significant effort to identify the data required, arrange for other departments to produce it, and to deliver the results to the researcher.

The health department has experienced staff reductions due to city budget restrictions (Dr. Joseph DeMayo, personal communication, December 31, 2004). One impact of the reduction was that the Health Department did not have the resources to research the problem and produce results within the time frame required for this effort. The researcher will spend time with Waterbury to adapt the East Hartford model as a basis for going forward.

4. Next Steps

a. Identify data available in Statewide Tracking of Elevated Lead Levels and Remediation (STELLAR)

The lead program in Waterbury uses the STELLAR database provided by the CDC. STELLAR provides the capability to export to formats that can be manipulated by ArcGIS for joining to spatial data.

b. Identify data available within Waterbury

If GIS datasets with the location and age of housing is available, these should be incorporated into the lead program GIS project dataset.

c. Add other relevant data

As in the other projects, generally available data should be added to the project dataset. Of particular interest would be the TOXMAP list of facilities releasing lead or lead compounds. Currently, no such facilities are within the Waterbury city limits, but several are in the vicinity, and these should be evaluated for potential impact.

d. Evaluate East Hartford results for relevance

The researcher has discussed the East Hartford project with Waterbury personnel. Given the similarity of the projects and their objectives, the results may be directly applicable.

Location of septic systems in Middlebury, CT relative to existing and planned sewer lines as input to town policy and regulatory processes

1. Objective

To identify areas of widespread septic failures as input to town planning and budgeting processes regarding sewers. Additionally, contribute to the development of GIS capability in the town government.

2. Description

The Town of Middlebury, population 6,451 (2000 census), has a part-time health department. As is often the case in small towns with part-time directors of health, much of the environmental health responsibility falls on the building official and/or sanitarian (which, in Middlebury's case, are the same person).

The building official/sanitarian responded to the solicitation for pilot projects. Given the state of Middlebury's GIS operation, the researcher indicated that Middlebury might be better served by receiving the results of all the projects, rather than being involved as a specific pilot. In meetings with several town officials on two occasions, it became clear that the town was committed to developing GIS to the extent that they could. Since the building official had a specific project in mind the decision to go forward was made.

3. Results

The first issue was data. Middlebury has an MS-DOS based database application customized by a part-time consultant. As a qualitative statement, this situation is not negative, because the application meets the needs of the town; however, the age of the application limits its capability and inhibits the ability to

upgrade, and the part-time support (by a single individual with a full-time job elsewhere) limits the ability to fix problems or make required updates.

The application allows entry, tracking, and printing of various permits. The researcher investigated the available documentation and determined that the application allows exports of data to tables that can be manipulated by ArcGIS. After working with an export of the entire database, it was discovered that septic permits were not retained in the database. This was by design, as at the time of creation computer disk space was scarce and expensive, and there was no anticipated need for the data.

The researcher now knew two things: it was possible to use the data in the database, but the required data did not exist in electronic form. The building official committed to use an intern (college student) to update the database, but this activity was dependent on the intern's academic calendar.

Table 7 shows the data used to create a map for demonstration. The demonstration map is shown in Figure 9. The colored dots represent various types of building permits, indicated on the map to validate geocoding. Since none represent septic permits, they are not included in the legend.

| Layer | Source | Comment |
|------------------|-----------------------------------|--|
| Town Boundaries | DEP Web Site: Towns | Clipped for Middlebury |
| Roads | DEP Web Site: NamedStreets | Clipped for Middlebury, symbolized by Legend by type of road |
| Permit Data | Middlebury Building Department | Geocoded by address matching, symbolized on PERMIT_TYPE to show how septic permits would have been displayed if we had them, restricted by definition query to addresses with some degree of matching success |
| Leachate Sources | DEP Web Site: Leachate | Clipped for Middlebury, labeled by LWNAME |
| Leachate Lines | DEP Web Site: LeachateLines | Clipped for Middlebury |
| Lakes | DEP Web Site: Named Lakes | Clipped for Middlebury, cross hatched to distinguish from Wetlands |
| Wetlands | DEP Web Site: WetlandSoils | Clipped for Middlebury, symbolized on WTLND_DESC to differentiate soil types |

Table 7: GIS layers added for Middlebury project

4. Next Steps

a. Complete update of septic permit data

In order for the project to proceed, the database must be updated with septic permit data, including as much history as possible. Hopefully, this can be accomplished through the efforts of the intern. If not, the town should engage professional support.

b. Replace permit table with septic data

Once the database is updated, it can be exported to a file format that ArcGIS can manipulate for geocoding. The existing layer created for demonstration purposes can be deleted.

c. Add other Middlebury-specific data

Middlebury has other GIS data available. If possible, land parcel data should be added to this project dataset.

d. Geocode septic data

Add spatial dimension to the septic permit data exported from the database application, either by address matching or by joining with parcel data.

e. Establish or update policies concerning data maintenance

All data that is stored electronically, regardless of GIS involvement, should have explicit policies for access, update, and archiving. With the addition of GIS capability, these policies should be evaluated for GIS applicability. For example, means of relating addresses to parcels for joining within GIS should be considered (the Unique Identifier used in the Chatham project is an example).

RESULTS

The pilot projects demonstrate that it is possible to execute GIS projects using LHD data without developing GIS expertise within the LHD. The overall objective of a sustainable capability has not yet been achieved. Time and experience will demonstrate that result. The experience of this thesis, together with the data on the accompanying CD, will provide a basis with which LHDs can move forward.

Two of three criteria applied to select pilot projects in this thesis should be applied by any LHD attempting an initial GIS project:

- operational GIS capability within the jurisdiction
- definition of a project that will provide value to the LHD

The third last criterion, use of ESRI GIS software, was included only for compatibility with the researcher's platform. Going forward, the important factor is to use what is standard within the jurisdiction. If that is not ESRI, then the files on the CD may require conversion that will involve additional time and effort.

Neither this thesis nor the CD is intended to be a tutorial for someone wishing to learn GIS. The original hypothesis was that LHDs can use existing skill to integrate with existing GIS capability. The pilot projects showed that this is possible given the foundation provided herein. However, it is not magic. The LHD still needs to do the work.

Key Findings, Observations, and Recommendations

The following is a discussion of the results of the analysis the data collected in this thesis, particularly through execution of the pilot projects. A summary of the project is shown in Figure 10. The results are categorized here as they relate to:

- GIS Technology (ability to apply the technology in LHDs)
- Scaling (applicability to organizations of various sizes)
- Confidentiality (issues of protecting data)
- Sharing (of data and responsibilities within jurisdictions)
- Data Availability (ease and cost of data acquisition)
- Data Quality and Currency (the accuracy and timeliness of available data)

Each category includes a recommendation for improvement.

GIS technology

The survey showed that a large portion of LHDs have access to GIS technology. The response to the solicitation for pilot projects indicates that there is great interest among health directors in applying the technology. One obstacle in using any technology, particularly new technology in the resource-constrained local government environment, is time and training.

Fortunately, none of the pilot projects required specific GIS expertise. The real challenges in each case concerned data, not GIS. The ability to capitalize on GIS expertise that exists elsewhere in LHDs' jurisdiction is dependent on defining a problem, not on developing expertise within the LHD. For example, with the Chatham project the complexity was in connecting property characteristics to assessor data, compounded by the change in map and lot identifiers. The resolution involved data manipulation in Access and Excel. Most health departments have access to basic Microsoft Office skills, and much of what was done in these projects using Access could be done in Excel by a person with intermediate skill.

Recommendation: LHDs should work with other agencies to develop inter-agency data standards

To make the process more efficient, standards that span departments would be useful. For example, a LHD is most likely to be going to an assessor's office for spatial data to which LHD data can be joined. It would be very useful for the assessor's office to consider this likelihood (for all departments, not just the LHD). Such standards would be guidance to the LHD (e.g.) for content and format of fields in spreadsheets or database tables that may require spatial representation.

East Hartford has such standards (Frank DeLuca, personal communication, October 29, 2004). There may be a challenge with respect to STELLAR, because the CDC-provided package is not developed locally, but the standards make definition of what information is needed from STELLAR, and what manipulation is required, possible.

When a municipality implements GIS, part of the implementation should be to develop standards such as how to refer to files and data elements, how data should be accessed, and what procedures are in place to prevent unauthorized access. In reality (as exemplified by these pilot projects), this is not a common situation. As a result, health directors will often be placed in the position of needing a place to start.

For this audience, the best course of action is to attempt to work with the organizations responsible (assessor's offices or land use departments in smaller jurisdictions, IT departments in larger ones) to develop standards. This does not have to be a large, bureaucratic undertaking. As will be discussed under the

findings concerning sharing (Section III.C.4), most departments are willing and able to provide some support. The standards regarding GIS data can start with documenting current procedures and analyzing them for potential revision to accommodate broader use of the data than was anticipated originally. With support from organizational policy (see Appendix B.1) this small step can go a long way towards making data available and useful.

Scaling

The pilot projects involved municipalities that ranged in population from under 1000 (Union, in the Northeast District) to over 100,000 (Waterbury). The variation in examples given under technology, above, is attributable to the size of organizations with respect to workload (related to the size of population served), budget, and staff. However, the ability to focus on GIS does not necessarily have a positive correlation with size. Both Waterbury and Middlebury, two very different communities with very different governmental structures, had constraints that inhibited their ability to participate in the pilots.

Nothing experienced in the seven pilots indicates that any constraints are related to size. While it is true that health departments in larger cities such as Hartford, Stamford, and Greenwich that replied to the survey indicate broader, more sophisticated GIS use, the degree of use appears to be more closely related to the process maturity than to the size of the organization. For example, Clinton is the Connecticut town with the smallest population (13,094 – 2000 census) having a full-time health department. The ability of the Clinton Health Department to use GIS is inhibited by the maturity of GIS in the rest of the town more than anything in

the health department. Clinton paid for GIS software in 2000, and paid an engineering firm to prepare GIS datasets for town features including land parcels. Unfortunately, there was no preparation for ongoing support of the system. The software has not been upgraded, no one was trained on GIS, and no plans were developed for interdepartmental communication regarding potential GIS use. As a result, the system is severely underused (researcher's personal observations).

Recommendation: Regardless of size LHDs should invest in process infrastructure

The recommendation for Clinton is the same as for any organization wishing to develop a GIS capability: develop a sustainable capability. The sample processes provided in this document (see Appendix B) are a start, and are based on IT industry standards for appraising process maturity. Scaling should be applied within the processes (i.e., different organizations will require differing levels of detail), but the concept remains constant. However, the same recommendation that is valid for Clinton and Middlebury is valid for Waterbury.

Confidentiality

Confidentiality is not as great a concern as might be anticipated. Much LHD data is available in the public domain. One exception is data concerning medical records or medical conditions, particularly those involving children. Regulations and procedures exist to protect medical data. Researchers and employees involved in GIS efforts should take the same care to abide by those regulations as they would in other contexts.

Nevertheless, LHDs should consider that some citizens may object to seeing their environmental characteristics publicized in graphic detail. For example,

citizens may not appreciate seeing their homes featured on maps showing the concentrations of ticks infected with Lyme Disease or birds infected with WNV, or in an area of widespread septic failures published in the local newspaper. What is legal and what is necessary and appropriate may be different in such cases.

Recommendation: LHDs should adopt and publish policies regarding data access

A way to avoid conflict in these situations is to develop and communicate a policy regarding what information will be made public under what circumstances (see Appendix B.1). The power of GIS amplifies the sensitivity to personally-identifiable data.

The policies may have to be developed, or they may already exist within the jurisdiction.

Sharing

LHDs are eager to participate in GIS projects, but a culture of separation of municipal responsibility inhibits cooperation. This is not a negative statement accusing departments of deliberately concealing data from each other. The lack of overall perspective is due in part to the departmentalizing of municipal budgets and budget authority. There is no motivation to share and, in a resource-constrained environment, the result is that sharing does not occur.

Recommendation: LHDs should work with their jurisdictions to develop policies and procedures regarding sharing of data and responsibility

In all of the pilot projects that produced results, part of the success was due to the willingness--to the point of enthusiasm--of individuals in departments other than the health department to contribute to the effort. What the individuals lack is

leadership demonstrated by explicit documented policies that makes sharing part of their jobs as opposed to something they do when asked or in their spare time. As in any technology implementation, GIS users require a reason to move and support for movement. Organizational structures do not help, but they are only obstacles if they serve as excuses to remain still.

Explicit policies and practices would also make sharing more efficient by avoiding unique responses to individual requests.

Data availability

Useful data exists in publicly available sites and within specific municipal agencies, however it is often poorly publicized and difficult to access. The problem often is not lack of data, but knowing what data exists and which are of the best quality.

Where data is restricted for security reasons, policies such as that DPH developed for the source water datasets for the Northeast District are critical. The challenges encountered in the Northeast District project provide an excellent case study of the inefficiency caused by lack of proper policy definition. At the time of the initial request, DPH had recognized the need for a policy regarding the source water data, and a policy was under development. In response to the request from the NDDH director, and from other concurrent requests from other LHDs, the policy development was accelerated (Tyler Kleykamp, DPH, personal communication January 3, 2005). Unfortunately, months were lost, and many persons who need not have been involved (e.g., the researcher, the director of

health, and water company officials) exerted considerable effort that would not have been necessary had DPH had the policy in place when the data was created.

DEP does a good job of providing information about the data it has available via the internet. Anyone who knows (or suspects) that DEP has GIS data can search for it on the internet. An internet search on “connecticut gis” returns the DEP Environmental and Geographic Information Center (EGIC) as one of the top choices, and the user is directed to datasets with relative ease of navigation. EGIC also provides the data that is available on its web site on CDs. A subscription service will notify the purchaser when updates to specific datasets are available on the web.

Another choice that is returned at or near the top (depending on the search engine, among other factors) is the University of Connecticut (UCONN) Map and Geographic Information Center (MAGIC), which is a repository of data that is available from a variety of sources, including DEP, the US Census, the US Geographic Survey (USGS), and the UCONN Center for Geographic Information and Analysis (UCCGIA). The datasets reside on the MAGIC site.

Data relevant to Connecticut users is also available from almost any conceivable government agency. ESRI also provides access to US Census and other data in formats that are usable directly by its software products.

The issue for the user is navigation. For example, when should the user go to the US Census, when to ESRI, when to MAGIC, and when to DEP? There are two responses to this question:

1. To assure access to the most current data, go to the site of the organization that is the source of the data (US Census in the above example)
2. To obtain access to the widest variety of data, go to a repository of datasets (MAGIC in the above example)

The trade-off to be assessed by the user is whether currency or navigation ease is more important. The fact that there is a trade-off at all is a problem. Because there are so many agencies involved, it is difficult to make a specific recommendation. With leadership from the federal government, the National Spatial Data Infrastructure could provide an organized portal through which data could be obtained. At present, the site focuses on the federal level, although some agencies to which it points (e.g., the National Oceanic and Atmospheric Association (NOAA)) provide state and local data. If and when national leadership of this type is established, that would be the preferred condition. Until then, sites such as MAGIC provide a useful, local vehicle. A move to a portal, pointing to existing, current datasets, rather than a repository (which requires constant maintenance to remain current) might make the site more useful. However, university facilities are vulnerable to policy shifts and the availability of grant funding. Given the public need for access to current, high-quality GIS datasets, leadership from the state government would be appreciated.

An advantage that repositories such as MAGIC have is the potential to provide useful historical information for comparative analysis. Sites that maintain the most current data may not archive data for historical purposes. A repository may do just that, so someone interested, for example, in the change in land use over time could

use a portal for the current data and a repository for historical data. For this to be effective, however, some collaboration on information architecture is required, including definitions of quality and currency and some authorization or certification of the data.

Another factor that inhibits access to data is the ability of organizations to charge for datasets. One example is orthographic photos. As described in discussions of pilot projects, DEP makes 1990 versions of orthographic photos available. As in the case of the Chatham project, these are often not useful. Photos taken from flyovers for specific purposes are costly. One estimate is \$200,000 for a 1,400 square-mile area (50) at 1 foot accuracy (40 scale). Connecticut covers 5,544 square miles (51).

In Connecticut, SBC Communications, Incorporated (SBC) conducts flyovers for its own business purposes and sells portions to cities and towns throughout the state. SBC does one-third of the state each year, so that no set of photos is ever more than three years old. The presence or absence of the resulting GIS datasets depends on the willingness and ability of the municipalities to afford to purchase the datasets from SBC (e.g.) or to fund their own flyovers. The cost to towns for the SBC data is by tile, with each tile covering about 1.7 square miles. One cost quotation for SBC data at 2.5 foot accuracy (100 scale) is \$8,000 for 41 tiles, or about 70 square miles (Patrick Ladd, City of Meriden, personal communication, January 3, 2005).

Recommendation: Organizations such as CADH should advocate for the State of Connecticut (through EGIC, for example) to make GIS datasets broadly available at minimal cost

For example, there may be an opportunity for the state to negotiate for a statewide dataset to be updated at frequent intervals that could be made available to cities and towns without compromising commercial interest. Since several entities (SBC, DEP, the Metropolitan District Commission, individual municipalities, et al.) conduct flyovers of the same area, the state would be providing major cost savings and providing consistent quality.

Such negotiation would solve one problem for one state. The larger problem is the trend of private organizations “owning” data and selling it to the public. There can be legitimate debate on what data is private and can be sold for profit and what should be public and available at no or low-cost. The researcher sees few examples of such debate yet many examples of private moves to acquire and sell data. Without this debate, the public interest in acquiring and using GIS datasets is unlikely to be served.

Data quality and currency

The situation with orthographic photographs discussed above points out other concerns regarding generally available data. Specifically referring to DEP data:

1. it is often out of date (1990 vs. some more recent version)
2. the quality is not the best (e.g., in the case of the photos it may be possible to obtain better resolution)

In the example of roads, the NamedStreets dataset available from DEP is quite old (more than 20 years, as evidenced by the lack of the researcher's residential street, which is 21 years old). Many areas in Connecticut are continuing to experience a high degree of commercial and residential development. As a result, new roads are created regularly. For the datasets to be useful, someone must take responsibility for updating them continually.

Another problem is fragmentation. In the Northeast District project, it became difficult to label and follow state highways, as they change names when they change towns, and sometimes change names within towns. An option would be to add an attribute for the state or US route name and carry that name consistently in all road segments. The addition in late 2004 of the Routes shapefile and associated data to the DEP web site reduces this need somewhat (note that it was ultimately included for the Northeast District Project). However, this inclusion is too late for those who have already struggled with the older data and the problem still exists for address matching. It is likely that other such situations exist, and DEP's work in this instance is encouraging (but not complete).

The issues of quality and currency are also related to accessibility. The requirement of the GIS community is to be able to access the most current single source of each dataset without concern for update frequency and consistency. The requirement is best filled by portals to a single repository, rather than multiple repositories. This is a goal that may take some time to reach. Some repositories were created to meet the need of increased access via private networks. With the advent of the internet, these repositories could be made available via public

networks and some became redundant with other previously private data sources. The cost and effort to determine which sources should be designated as the single source, with all the accompanying issues of maintenance, support, and update frequency, along with the cost and effort required to shift the existing approach to a portal, are a significant barrier to establishing the approach that best serves the community.

Recommendation: Organizations such as CADH should advocate for the State of Connecticut (through EGIC, for example) to document GIS data needs and publish a plan for meeting those needs

Leadership is required. Since the context of this document is local public health and local government, the responsibility for leadership falls above that level. In Connecticut, the public entity above the local level is the state. Therefore, if GIS is to flourish in Connecticut, the state government must expand its role in GIS leadership beyond the current activities. EGIC is a good start, but if GIS data remains in its current condition for much longer, the emerging efforts of local entities (such as health departments) will be frustrated by the inability to access data and by the quality of the data they can access.

CONCLUSION

The results of this thesis indicate that LHDs can apply GIS without developing significant GIS expertise on their own. The prerequisites for the pilot projects (having a specific need that can be addressed by GIS, and having a functioning GIS capability within the jurisdiction) hold for any LHD attempting to develop a GIS capability of their own. Health districts may find it more difficult, as varying processes and capabilities within various towns in a jurisdiction may make district-wide projects difficult. Even with this exception there is enough work within individual towns in health districts to justify beginning a GIS program in most districts.

The issue of available, low-cost, high-quality GIS data is somewhat less encouraging. Without leadership at the state and federal levels, the current condition of hard to find, hard to verify, and sometimes expensive data will continue. Within the context of this thesis, it would be very useful for Directors of Health to join with other agencies that need GIS data to advocate for leadership from the state.

The companion CD produced through the work of this thesis will be distributed to directors of health in Connecticut and other interested parties. The contents of the CD provide a foundation on which LHDs can build to develop a GIS program.

APPENDICES

A. Figures

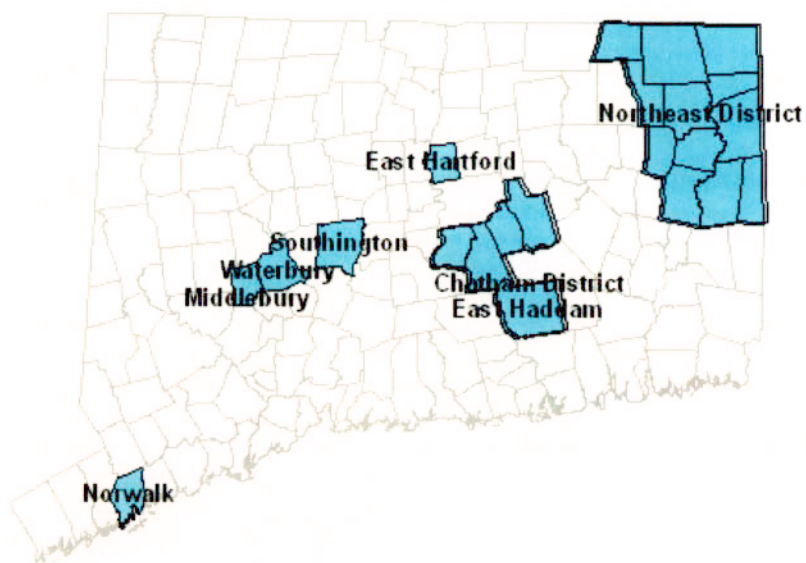


Figure 1 – Location of Pilot Projects

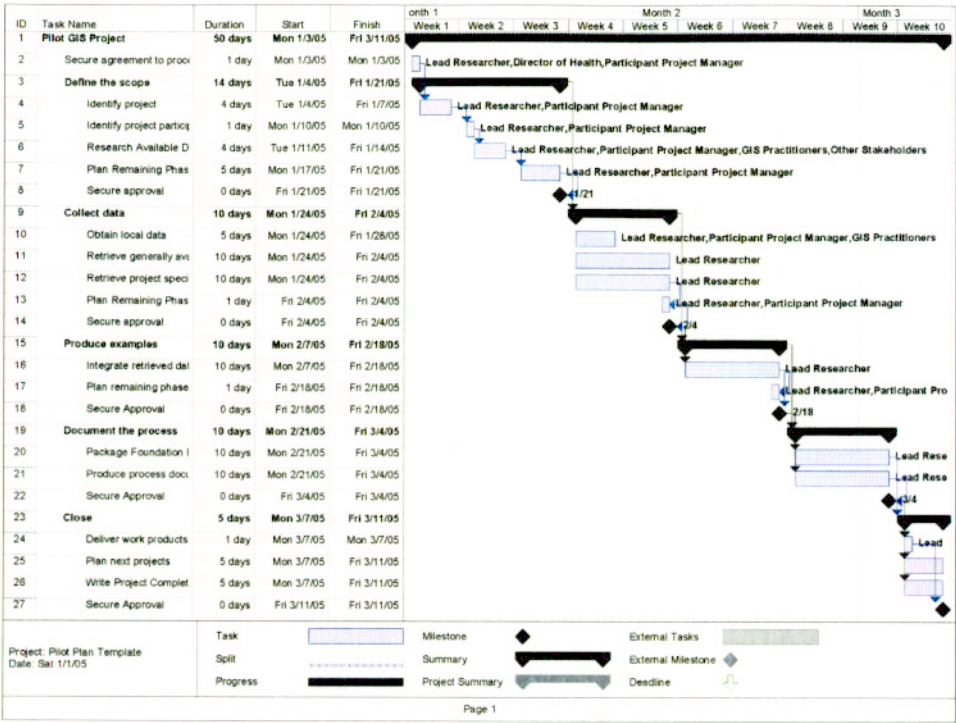


Figure 2 – Model Pilot Project Plan

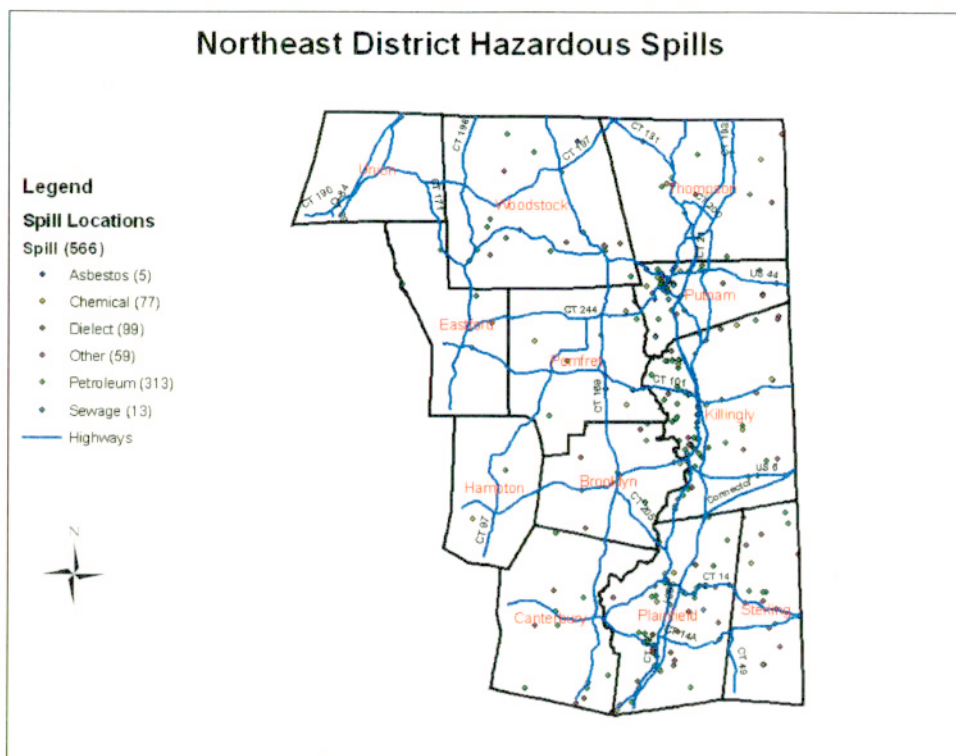


Figure 3 – Northeast District Small Scale Example



Figure 4 – Northeast District Large Scale Example

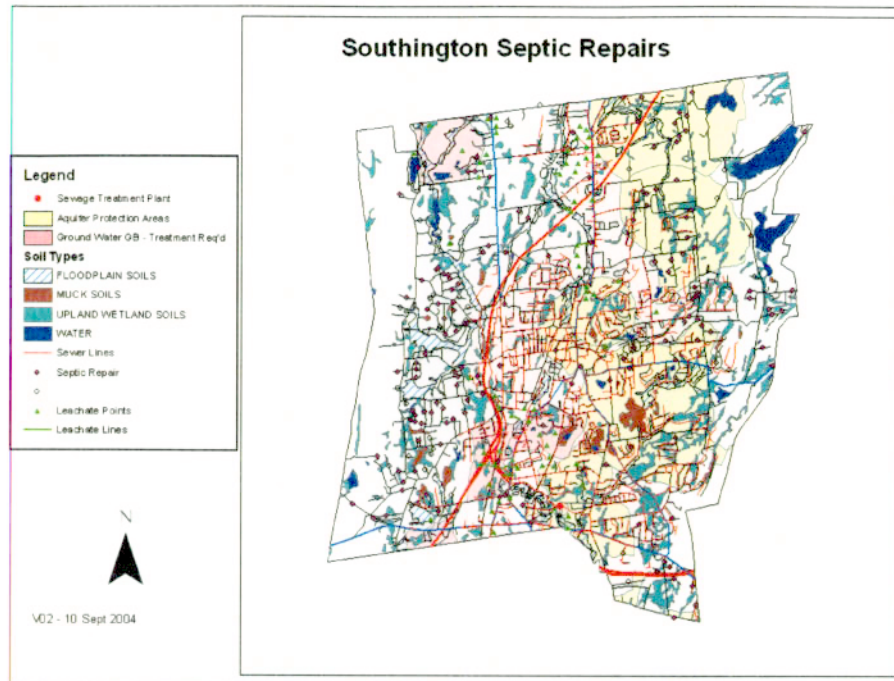


Figure 5 – Southington Example

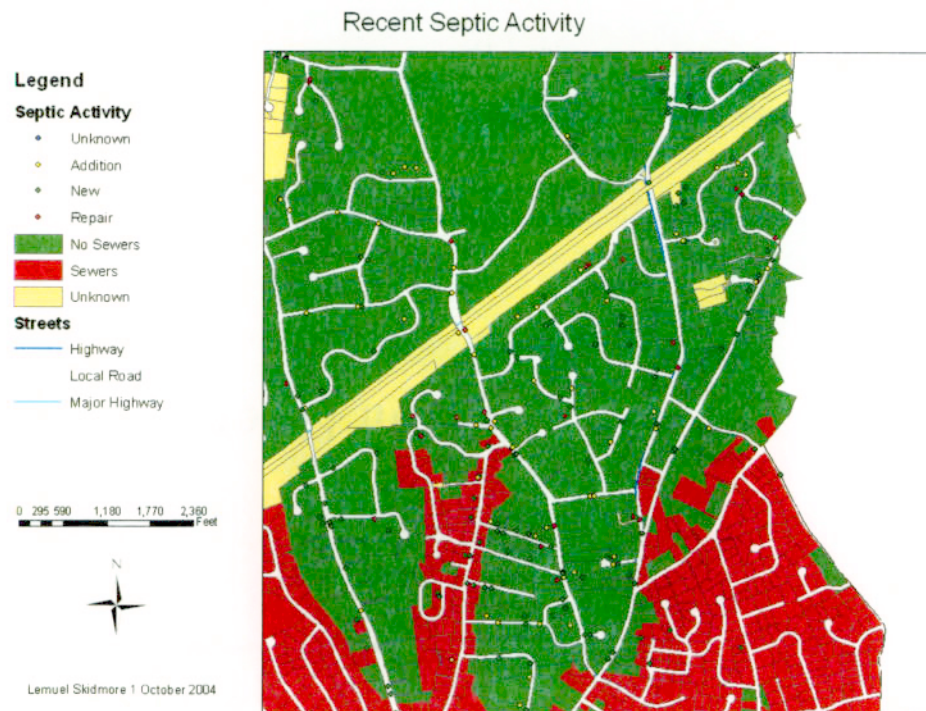


Figure 6 – Norwalk Example

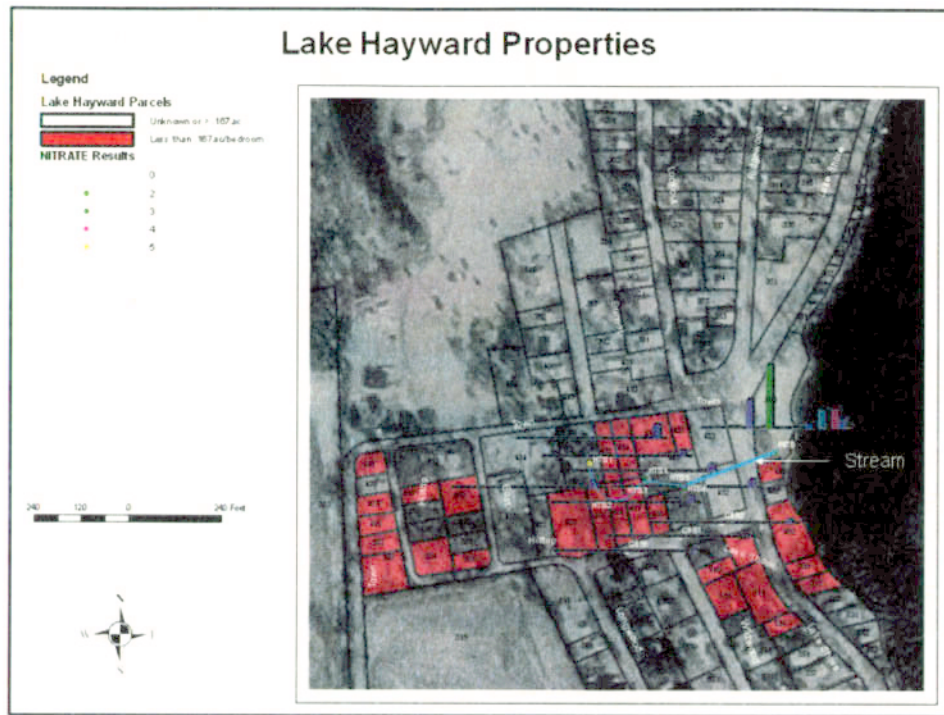


Figure 7 – Chatham Example

East Hartford Vulnerable Population and Age of Housing Stock



Figure 8 – East Hartford Example

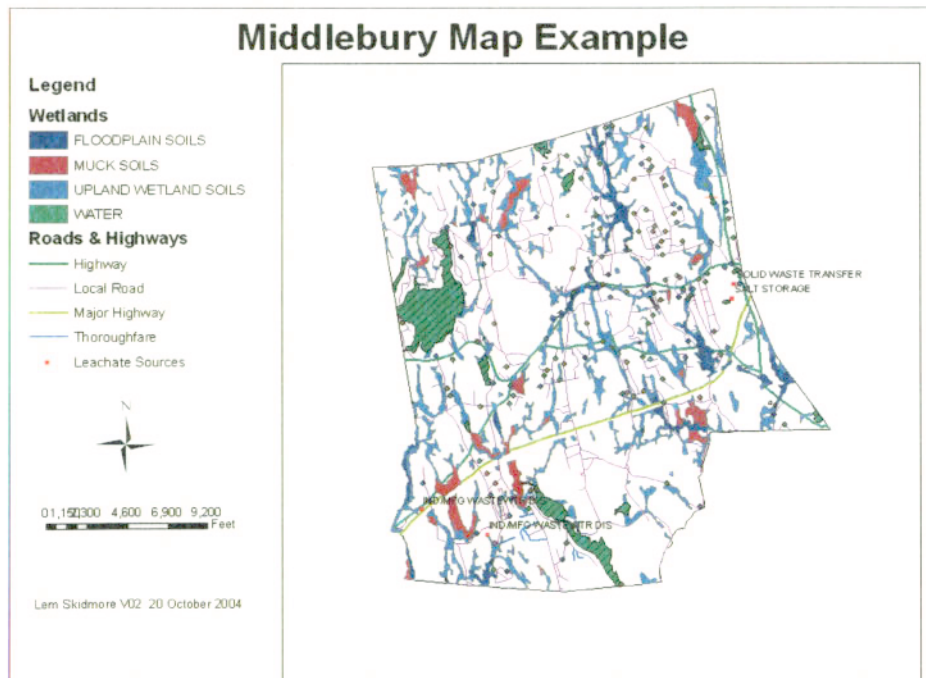


Figure 9 – Middlebury Example

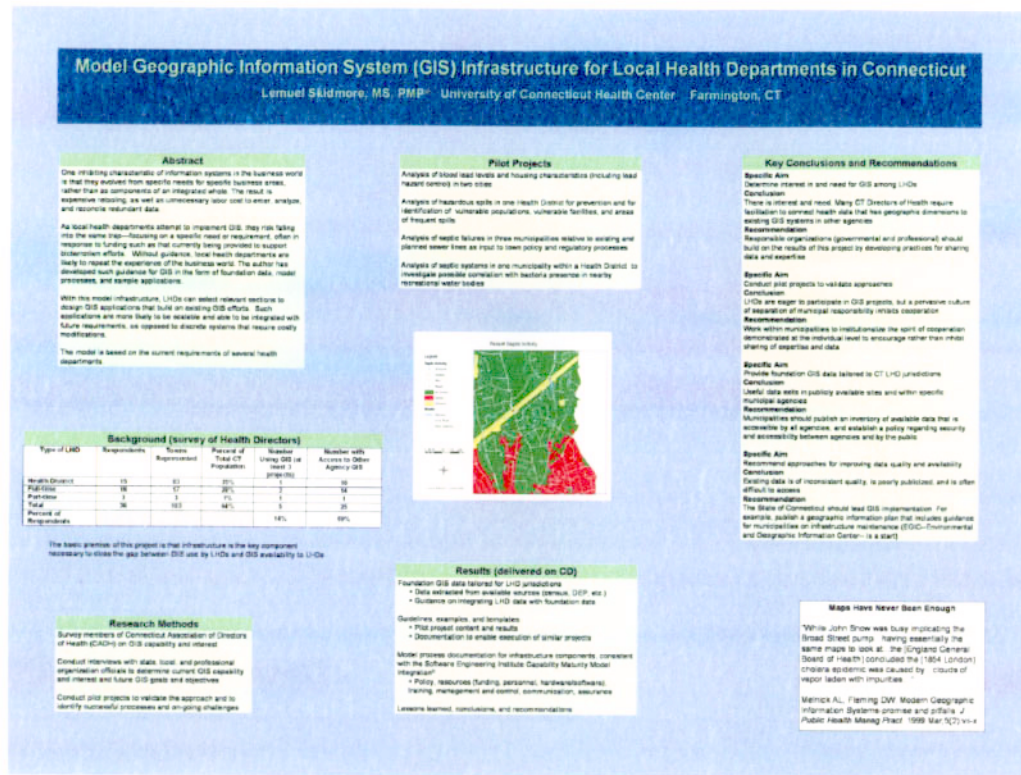


Figure 10 – Poster Describing the Project

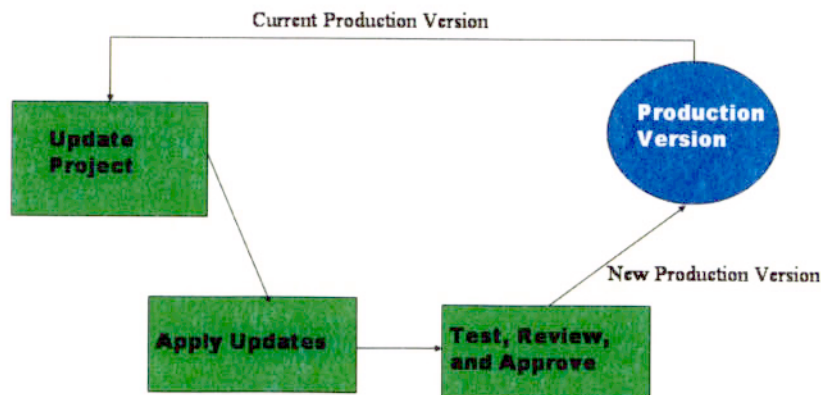


Figure 11 – Configuration Management Process

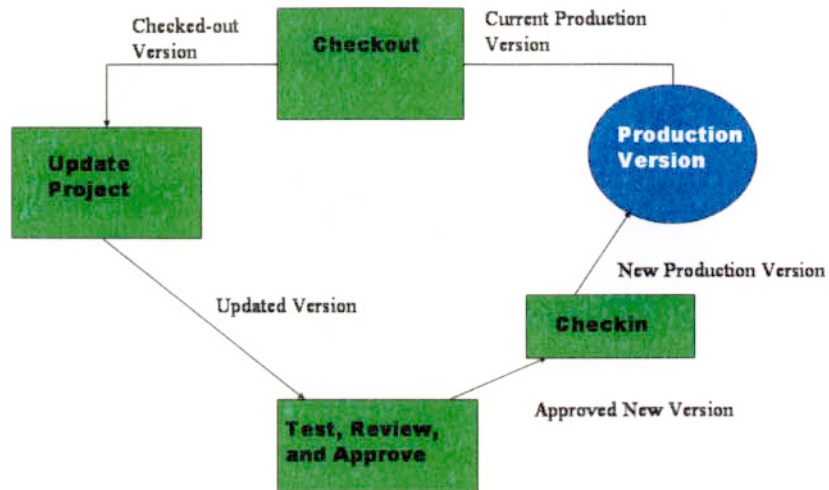


Figure 12 – Configuration Management with Check-in/Check-out

B. Model Practices Applicable to Connecticut Local Health

Departments

The following processes are based on the requirements of the Software Engineering Institute Capability Maturity Model (44), described above.

The researcher makes no claim and sets no expectation of the results of appraisal against that model. However, the status of this model as an IT industry standard establishes it as a sound base on which to build a capability. The focus of this document is GIS, but the concepts applied here may also be applied to other areas. Also, the constituency for this document is health departments and directors of health. Ideally, the context can be broadened to encompass other parts of jurisdictions. Notes are included as guidance for potential involvement of other parties.

The processes are presented with the intent that users will adapt the wording and terminology (or replace them altogether) to reflect local requirements.

Policy

The health department has an interest in spatial representation of data. Data files will be created, received, and updated through normal operations of this department. All such data files (and the design of such file) are to be examined for potential spatial representation.

Factors to be considered are:

1. Software used

All datasets are to be recorded in tabular form in software that is standard for this organization. Excel will be the most typical, but where relational capabilities between data files is required, Access is the tool of choice.

Note: the specific software will depend on the organization. Hopefully, a municipality has a standard platform that is mandated. In such cases where the standard platform does not include Microsoft Office, substitute the standard spreadsheet program for Excel and the standard database program for Access.

2. Relationship to spatial data

Assure that the data is formatted properly so that the file can be represented spatially

Note: There are at least two ways to create spatial dimensions. One would be address-matching. Address matching requires that street names are spelled correctly and consistently. Another common way would be to match to parcel data that has been created in other departments. In this case, the map and lot number, or other parcel identifier, will be needed (e.g., from the assessor's office).

3. Confidentiality

Confidentiality requirements for the data will be considered. As appropriate, access to data (and to reports, maps, and other computer-generated material) will be restricted according to legal requirements (e.g., HIPAA) or existing policy.

Note: policies concerning data either exist or they do not. If they do not, they must be established before a health department considers GIS implementation.

Program Planning

The GIS program at this health department will be managed according to project management principles. For the overall program there will be a project manager who will prepare a task plan including estimates of duration, risks and a risk management plan, specific roles assigned to tasks, and defined deliverables. One of the tasks will be to develop standards for operating individual GIS efforts (which will include a project manager, tasks, risks, deliverables, etc.). The plan will be monitored and updated as required during each fiscal year, and will be revised as input to and as a result of the annual budget process.

Note: the project manager is a role, not a position. The role could be filled by an individual or department with no other responsibilities, but it is much more likely that the role will be served as part of another position. In some departments it might be the health director.

Resource Definition and Plan

The health department GIS project manager will establish a plan for resources to support the GIS program. The plan will include roles and skills required to fill each task in the program plan.

Note: this is a definition of required resources, not a personnel plan. The project manager for each effort will assign people to roles. The people may be from the health department, from other departments, or from outside resources depending on skills available.

In addition, the project manager will identify non-personnel resources such as hardware, software, training, and travel that may be required. If these resources

have not been funded as part of other efforts, the funding required for acquisition and maintenance should be included in the resource plan.

Responsibility Assignment

The GIS project manager is responsible for the health department GIS program. The project manager has authority over all GIS efforts operating within the health department, including approving and monitoring the execution of plans for such efforts.

Training Program

Part of each annual program plan and resource plan is a skills plan. The skills of available personnel should be assessed against the plan. This assessment may reveal gaps between the skills needed and the skills available. Options are to hire additional personnel with the required skills, engage contract resources with the required skills for the life of the contract, or to train existing personnel.

If training is the chosen option, the GIS project manager will create a training program that includes available training courses (public classes, private training, mentoring, documentation, etc.) and numbers of people to undergo each type of training. No task should be initiated until the assigned personnel have been trained according to plan.

Configuration Management

Configuration Management in this context refers to assuring that all documents and datasets conform to a structure by which the version currently in general distribution (production version) is protected from update until the current work effort is completed and approved by the appropriate parties. At that point, the

products of the current work effort become the production version, and the newly replaced production version is archived. Figure 11 contains a diagram of this process.

One situation that occurs with increasing frequency as the size and/or activity of the organization increases is multiple updates of the same dataset. Referring to Figure 11, if two discrete work efforts plan to work with same production file, they each check-out a copy according to procedures, and both apply their changes to the file. When the first project is complete, and is approved a new production version with the results of that work effort is created. When the second project completes, it replaces the results of the first project's work, but does not contain the results of that projects updates, which are now lost.

To prevent this situation, larger organizations will have software that manages the Check-in/Check-out process. Smaller organizations will have to take care using other means such as manual Check-in/Check-out as shown in Figure 12. Without configuration management procedures, problems with updates are very likely to occur, and their cause can be very difficult to detect.

Another situation avoided by proper configuration management is version control. There should be no doubt which versions are current, which are obsolete, and which are works-in-process. For software and data, the Check-in/Check-out process just described (either automated or manual) is desirable. For documents, a document registry is required. This can be as simple as an Excel spreadsheet with the names of all documents under configuration management, the name of the current responsible person, the current version number, current version date, and the

location of the current version (hardcopy file or computer directory). An organization standard should mandate a change log at the beginning of each document. This log will be updated each time a new production version is created, and will include a description of each change, the reason for the change, the person making the change, and the date. It will be a running log containing all changes from document creation until document sunset. In addition, standard page footers should include the version number and version date.

Stakeholders Plan

The key activity here is to identify and involve relevant stakeholders. As defined in the CMMI (44), a stakeholder is someone who is affected by the program. A relevant stakeholder is someone with a role in the program plan. The project manager should identify all such persons and get their commitment to the plan. A formal way to do this would be through a document of understanding (DOU) that specifies roles, responsibilities, and deliverables in detail. In smaller organizations, depending on the size and risk level of the program, DOUs may take the form of simple memoranda or e-mails. However, DOUs must be written, and must contain the description of roles, responsibilities, and deliverables.

Program Monitoring and Control

The project manager is responsible for reviewing program status including actual time and costs vs. estimates, personnel assignments, and deliverable quality. The project manager will take corrective actions, which may include requests for additional funding or program alteration or termination. The project manager must

also monitor ongoing results of each project operating under the program, and has the authority to take any of the same corrective actions.

Process Assurance

The project manager is responsible for assuring that the program meets the quality standards set forth in the program plan, and also meets any standards mandated within the jurisdiction. Similarly, the project manager will review the progress of each of the projects operating under the program to assure that they are performing according to the program's quality standards. Quality standards include such criteria as cost and schedule performance, deliverable quality, and reporting criteria.

Status Review Plan

In the context of this document, the project manager is most likely responsible to the health director. The project manager should have regular (e.g., monthly), scheduled reviews of the GIS program's status. The review should include completed accomplishments, planned accomplishments, risks, and issues on which the health director's assistance is required.

The health director should include the same reporting on a regular basis (e.g., quarterly) to the authority to which he is responsible (e.g., Board of Selectmen or Board of Directors).

C. Survey Instrument with Summary of Responses

36 responses. One page 3 not returned (Questions 7-10).

Percentages may not sum to 100% due to rounding.

Please check the one best response, except where multiple responses are requested:

1. Is your health department a:

- | | |
|--|-----------|
| <input type="checkbox"/> Full-time health district | 42%, n=15 |
| <input type="checkbox"/> Full-time municipal health department | 53%, n=19 |
| <input type="checkbox"/> Part-time health department | 6%, n=2 |

2. How would you rate your health department's familiarity with GIS?

- | | |
|---|-----------|
| <input type="checkbox"/> There are one or more experts on staff | 33%, n=12 |
| <input type="checkbox"/> See the potential, but need to know more | 47%, n=17 |
| <input type="checkbox"/> No/minimal familiarity | 19%, n=7 |
| <input type="checkbox"/> I don't know what our familiarity is | 0%, n=0 |

3. To your knowledge, is GIS used by other agencies in your jurisdiction?

- | | |
|---|-----------|
| <input type="checkbox"/> Yes, there is at least one department using it heavily | 69%, n=25 |
| <input type="checkbox"/> It exists, but no one is using it very much | 17%, n=6 |
| <input type="checkbox"/> It exists, but I don't know much more about it | 3%, n=1 |
| <input type="checkbox"/> I don't know (or "No") | 11%, n=4 |

4. In the last 12 months, for how many projects (discrete work efforts) has your health department used GIS software?

- | | |
|---|-----------|
| <input type="checkbox"/> None (please proceed to question #7) | 61%, n=22 |
| <input type="checkbox"/> 1 or 2 | 25%, n=9 |
| <input type="checkbox"/> 3 to 5 | 3%, n=1 |
| <input type="checkbox"/> More than 5 | 11%, n=4 |

Questions 5-6 answered by the 6 responders who have used GIS. Responses tabulated as a percent of those responders and of the total surveyed.

5. For what has your health department used GIS? (please check all that apply)

Create

A. Maps to identify facilities:

- ☐ Medical (hospital, clinic, etc.) 29% of responders, 11% of total; n=4
- ☐ Restaurants 29% of responders, 11% of total; n=4
- ☐ Septic 57% of responders, 22% of total; n=8
- ☐ Sewage treatment 14% of responders, 6% of total; n=2
- ☐ Water treatment 14% of responders, 6% of total; n=2
- ☐ Water supplies 21% of responders, 8% of total; n=3
- ☐ Other facilities 71% of responders, 28% of total; n=10
 - a. B-100 Analysis/additions
 - b. Complaints/Service Requests
 - c. Community Agencies
 - d. DEP catch basin survey
 - e. Emergency preparedness, disease surveillance
 - f. Hazmat facilities, schools, special populations, rubbish routes
 - g. other properties
 - h. Vulnerability to terrorism, baited traps for Lyme ticks, Helicopter deer survey
 - i. WNV birds, day care facilities, pools, permits/licenses
- ☐ Zoning/Property Boundaries

D. Document Events

- ☐ Ticks tested 29% of responders, 11% of total; n=4
- ☐ Birds tested 43% of responders, 17% of total; n=6
- ☐ Septic failures 21% of responders, 8% of total; n=3
- ☐ Private Well tests 7% of responders, 3% of total; n=1
- ☐ Inspections 21% of responders, 8% of total; n=3
- ☐ Traffic accidents 7% of responders, 3% of total; n=1
- ☐ Communicable diseases 21% of responders, 8% of total; n=3
- ☐ Other event 21% of responders, 8% of total; n=3
 - a. Complaints
 - b. Emergency Preparedness
 - c. IPM issues

E. Other Use 7% of responders, 3% of total; n=1

- a. Results of depression survey

6. What has been the primary reason for using GIS?

- ☐ Recognized the value for one or more projects
57% of responders, 22% of total; n=8
- ☐ Personal interest (yours, or another employee of your health department)
0% of responders, 0% of total; n=0
- ☐ One or more towns in my jurisdiction has required or recommended it
0% of responders, 0% of total; n=0
- ☐ Other
43% of responders, 17% of total, n=6
 - a. Both see value and one or more depts. recommended (n=1)
 - b. Both see the value and personal interest (n=5)

Questions 7-10 (page 3) answered by 35 respondents. Percentages tabulated using total of 35.

7. Do you see any obstacles to GIS use in your health department?

- ☐ No 26%, n=9
- ☐ Yes (please check all that apply) 74%, n=26
- ☐ Don't know what we would use it for 11% of responders, 9% of total, n=3
- ☐ Cost 62% of responders, 46% of total; n=16
- ☐ Training 81% of responders, 60% of total; n=21
- ☐ Time 81% of responders, 60% of total; n=21
- ☐ Resources 58% of responders, 43% of total; n=15
- ☐ Other 19% of responders, 14% of total; n=5
 - a. Integration and seeders
 - b. No staff
 - c. Requires municipal buy-in for cost sharing
 - d. Value, need
 - e. need staff to make it worthwhile

8. Which of the following would assist your LHD as a new GIS user or with your continuing operations of GIS? (please check all that apply)

9. Resources

- ☐ Funding 69%, n=24
- ☐ Training 86%, n=30
- ☐ Planning and direction 66%, n=23
- ☐ GIS Infrastructure (hardware/software/data) 66%, n=23
- ☐ Other 29%, n=10
 - a. Demonstrated practical value
 - b. Additional Personnel
 - c. Description of regional benefits
 - d. Real GIS dept in the city
 - e. Staff (n=5)
 - f. Understanding

10. Increased capability within your jurisdiction

- ☐ GIS interest/capability across other departments 40%, n=14
- ☐ GIS interest/capability across all towns in the district 26%, n=9
- ☐ A starting set of GIS data tailored for your town or district 63%, n=22
- ☐ Other 6%, n=2
 - a. coordination with existing agencies
 - b. sustainable capacity

11. Please check if you would like information on participating as a pilot site

- ☐ Yes 63%, n=22

Please add any comments you may have about GIS and Public Health: 31%, n=11

- a. 2 staff members trained on Maptitude
- b. Aerial photography is expensive. Start up costs are high, and benefit to HD is difficult to demonstrate
- c. GIS helps visualize coexistence of indicators
- d. About to implement--interested in opportunities for shared training
- e. Need to understand the return on investment
- f. COGs are using GIS, and any municipal use should understand interfacing req'ments .
- g. Dir, Env Serv & IT mgr are interested in GIS & Public Health
- h. Great potential, little or no resources to do the work.
- i. State should institute to see issues on statewide scale--numbers too small to be widely meaningful in some of our towns (tracking disease, etc.)
- j. Tied into town's GIS system and coordinator. Print maps, prop owner infor, complaint inv/mapping.
- k. Would like to work on GIS project

D. Contents of Companion CD-ROM

The contents of the accompanying CD are organized according to the following directory structure. The Connecticut Association of Director of Health will duplicate the CD and distribute copies to CADH members at a membership meeting in early 2005. The date in the file name of 050131 (January 31, 2005) is estimated and may be adjusted when the CD is created.

Some towns provided a great deal of data. In the interests of conserving space and protecting confidentiality and ownership of the data, only the subset relevant to the sample mapping projects is included.

Documentation

Thesis (Thesis for Distribution – Lemuel Skidmore 050131.pdf)

This document in Adobe Portable Document Format (PDF)

Model Project Plan

Tasks, milestones, resources, assignments, and other project components as an MS Project template (Skidmore Model GIS Project Plan 050131.mpt)

Gantt chart view of plan as a PDF file (Skidmore Model GIS Gantt 050131.pdf)

Web page view (tasks, resources, assignments) as a PDF file (Skidmore Model GIS Project Plan (Web Page) 050131.pdf).

Key findings and associated recommendations from pilot projects (Skidmore Findings and Recommendations 050131.pdf)

Model practices excerpted from this document (Appendix B) as a separate document in Microsoft Word format for modification as required (Skidmore Model Practices 050131.doc)

Text file with information about CD contents (open with Windows Notepad)

(Skidmore Readme.txt):

1. Description of zip archive contents and instructions on extracting the contents
2. Instructions for downloading and installing free ArcExplorer software and using it to view the ArcExplorer map format included in each pilot project archive (for those without access to other GIS software)
3. References to web sites for retrieving GIS data

Pilot project results

For each project:

GIS Data - self-extracting zip archive with GIS layers and associated GIS files

(Skidmore *project name* GIS 050131.zip)

Documentation - Results section from this thesis as a PDF file (Skidmore *project*

name Results 050131.pdf) plus anything produced specifically for that project

E. Glossary of GIS-related Terms

The following brief glossary describes some of the terms used in this thesis. Most are GIS terms, but some are terms that either are not commonly used or are used with uncommon meanings. For a more complete list of GIS terms and definitions, see the on-line ESRI GIS Dictionary (52).

clipping

The process of reducing the geographic components of one dataset to the confines of another geographic data set; e.g., using a dataset that represents the boundaries of one town in Connecticut to “clip” just the lakes contained within that town from a dataset that has all Connecticut lakes

flyover

A session of photographs taken from an aircraft with the intention of converting to orthographic photographs (orthophotos) for inclusion in GIS datasets (e.g., SBC does a flyover of one-third of Connecticut each year, producing orthophotos for that section of the state)

geocoding

The process of locating non-spatial data, such as a street address, on a map using map coordinates (latitude and longitude) or a reference dataset (e.g., a set of address ranges that has already been geocoded)

orthographic photographs (orthophotos)

Two-dimensional photographs that are referenced to the features of the earth’s surface for inclusion in a GIS dataset

shapefile

A set of files that contains the location, shape, and attributes of a geographic features

spatial data

Data that contains a spatial dimension so that it can be represented geographically

spatial dimension

The location of a geographic feature on the earth's surface

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